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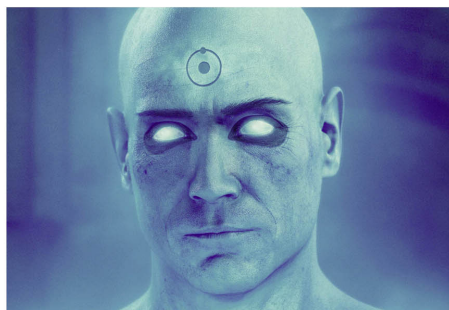
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Urban Renewal

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Article by Jody Duncan

Of the 32 films directed by Clint Eastwood over the past 37 years, only two — 1982's *Firefox* and 2000's *Space Cowboys* — could be classified as big effects films. For subject matter, Eastwood is most often drawn to stories about common people in extraordinary circumstances: a local Boston antihero and ex-con dealing with the murder of his daughter in *Mystic River*; the relationship between a small-town girl turned boxer and her reticent trainer in *Million Dollar Baby*; the workaday backstories of ordinary young men facing the bloody battle on Iwo Jima in *Flags of Our Fathers*. Eastwood's recent offering, *Changeling*, was in the same mold — a true story about a mother, Christine Collins (Angelina Jolie), who takes on a corrupt 1920s-era Los Angeles Police Department when her son goes missing.

With his films of the past decade, Eastwood has given lie to the adage about teaching old dogs new tricks. As he entered his seventies, Eastwood began to embrace state-of-the-art digital effects to help tell his cinematic stories, often collaborating with visual effects supervisor Michael Owens. "I started working with Clint Eastwood on *Space Cowboys*," Owens related, "and I've been doing visual effects for him ever since. After *Space Cowboys*, I thought that was probably the end of my working with him, just because I didn't think he'd ever do that type of effects movie again — and, so far, he hasn't. But what is interesting is that he's gradually come to rely on visual effects even for his movies that are not at all visual effects movies. By the time we got to *Changeling*, Clint was very comfortable with visual effects as just another filmmaking tool. He's not intimidated by visual effects at all, and he's happy to use them."

Eastwood utilized visual effects in *Changeling* primarily as a means of depicting 1920s and 1930s Los Angeles environments. With Owens, Eastwood designed shots that would incorporate matte paintings and 3D set extensions to augment plates shot on the backlot at Universal Studios and on locations around Los Angeles. "We shot quite a bit on the main street at the Universal backlot," said Owens, "and we put a bluescreen at each end of the street so we could add our environments. Normally, Clint does not like to use bluescreen. Roto is so capable today, I prefer not using it, as well; you get better, more natural light without it. Clint didn't want to slow down for bluescreen in this show; but if I absolutely had to have it, he'd let me have it. In the case of the backlot shots, it didn't cost him any time to have bluescreens there. We just put them up ahead of time, one at each end of the backlot, and then we didn't touch them."

Effects artists extended the backlot main street at both ends and also replaced half of the backlot set with CG structures. "That main street is so recognizable and has been used so many times," said Owens, "we decided to rebuild a lot of it in 3D to make it look different. We also enhanced the practical locations where we shot, such as City Hall in downtown Los Angeles. We had to spruce that up to make it look as it would have in the 1920s."

The effects shot count totaled 180 by the time Owens delivered the show. CIS Vancouver, under the supervision of Jeff Hancock, handled all of the 3D environmental effects, while Pacific Title & Art Studio executed the 2D work, with Mark Freund supervising. "We extended all the backgrounds,"

said Owens, “adding buildings, vehicles and trolley cars. They had one trolley car on the set that was somewhat operational, but all the others were CG, built from photographic reference. We also put in all the cables, because it would have been impractical to try to do that physically. In addition to buildings and vehicles, we created background crowds using Massive. On top of all of that, we did the typical cleanup of things.”

Owens initiated the project by reviewing books of photography illustrating Los Angeles as it looked in the 1920s and ‘30s with Eastwood and producer Robert Lorenz. “We discussed what kinds of shots might enhance the viewer’s experience,” recounted Owens. “I went through and picked out some scenes that I thought could be enhanced nicely with effects, and I sent those to Clint, along with some stills we found. We built up the shots from there. We wanted the most dramatic impact we could get, but without the effects being too much in the forefront. We wanted to show that this was the time and place, but we didn’t want to be in your face about it. The look of the city, setting that time period, just gave the story a little more credence and helped to involve the audience more. That was the intention.”

Visual effects contributed to the film’s opening, a wide shot that first establishes the city of Los Angeles, 1928. The camera then booms down through some trees to establish the Collins neighborhood and house. “I had suggested an opening shot that was like a vista,” Owens noted, “starting in downtown, and then booming down from this overview of the city to Christine Collins’ neighborhood. We shot some plates in the backlot just for that, and the idea was that we’d create the big overview of the city. Then, on location in San Dimas, which is where they shot the Collins neighborhood, they shot a plate coming out of the trees, which is the B side of that opening shot. Clint just figured he’d do a dissolve between the A-side view of Los Angeles and this B-side plate; but I suggested that it would be better if it were a continuous shot. I thought it would be more elegant that way. So we decided to make it a matte painting/visual effects shot. The challenge was hooking up that visual effects shot to the plate they’d shot to introduce the Collins home, since it had been shot with the idea of its being a dissolve. In the end, we had to shoot a middle-ground element to go between the trees and come out of the high-angle CG matte painting. The purpose of the shot was to say, ‘Here’s 1928; here’s about where we are geographically from the city’ — a view from the Hollywood Hills area — and then you come back down and you’re in her neighborhood. It was a simple way to relay that information to the audience.”

In San Bernardino, situated about 50 miles east of Los Angeles, was a train station that served as the setting for a pivotal scene in which Christine Collins goes to meet with a boy — found traveling with a vagrant in the Midwest — the police claim is her son. “When they first arrive at the train station there is a big, sweeping panoramic, boom-down shot,” Owens said. “That was all shot out at San Bernardino and then completely replaced, except for the train station building itself, which has been refurbished — inside and out — to look like a period



Director Clint Eastwood’s Changeling recounts the true tale of Christine Collins (Angelina Jolie) who takes on a corrupt Los Angeles Police Department after the abduction of her young son by a pedophile. The effects assignment for visual effects supervisor Michael Owens and the crews at CIS Vancouver and Pacific Title & Art Studio was to extend and transform studio backlot sets and locations in

[illegible]

n, when Christine arrives at the police station
n held — with her son, Walter — at the
east of Los Angeles. Effects crews created a

A wide-angle view of the main street in the Backlot of the MGM Studios. The street is lined with various classic cars parked along the sidewalks. On the left, there are several buildings, including a large, light-colored building with many windows and a smaller building with a sign that reads "MGM". On the right, there is a large, ornate building with a sign that reads "MGM". In the background, a large blue screen is visible, likely used for filming. The street is paved with cobblestones and has a few people walking on the sidewalks. The overall scene is a detailed recreation of a classic Hollywood movie set.

The backlot main street at Universal Studios provided a setting for many of the film's shots of 1930s-era downtown Los Angeles. Though Eastwood – known for the fast pace of his shoots – typically prefers to use rotoscoping techniques for his visual effects shots rather than slow down production with the placement of bluescreens, he agreed to the installation of permanent large bluescreens at either end of the Universal street set to facilitate CG set extensions.

o we literally had to jam through the whole
in that timeframe, it was impossible to finish
ot. It was just too big of a deal. So they went

to black for the credits in the film as it was seen in Cannes; and it was obvious that it was underwhelming. At that point, Clint said, ‘Okay, Michael, go ahead and do that shot so we can do credits over picture.’” The filmmakers shot the original plate for the end credits on the Universal backlot, but — except for the foreground buildings on the left side — the effects team replaced nearly everything in frame.

Keeping the shot alive for the full two-and-a-half minutes was a daunting prospect for Owens and the crew at CIS Vancouver. “Because the shot was so long,” Owens explained, “the people at CIS Vancouver were a little nervous about it, I think. There was so much other stuff to deliver on the movie at that point, I was less worried about it. I just knew we’d have to break it up into small pieces and figure it out that way — and that’s what we did. We took it in chunks, because we couldn’t sit there for two and a half minutes and watch a take. We had to break it up into pieces and elements for viewing; and then, at the last, we put it all together.”

In addition to filling the shot with synthetic buildings and traffic, CIS Vancouver augmented extras shot on the backlot set with Massive characters. “We had shot the plate with a bunch of extras and cars,” said Owens, “but shortly after the take began, most of the vehicles broke down and the extras missed their cue to walk through again. So what we ended up doing was selectively cross-fading to an empty plate, which we created from the only take we shot. One of Clint’s unique and admirable qualities is that he usually shoots very few takes — sometimes just the rehearsal! This shot was a typical ‘oner.’ The camera was on a crane, and it boomed up first, then locked off. Once it was locked off, we were able to start cross-fading to the clean plate. Occasionally, we’d let some extras from the original plate come in, and we’d just choreograph the Massive characters to work around them. We just kept massaging it, and it worked very well — although I can still see the occasional CG character or extra coming through frame twice. Next time out, I’m going to ramp up the Massive and character rendering to yet another level. The technology is there; how smooth it looks is just a matter of time and input.”

Owens views 180 effects shots in a non-effects movie as a credit to the effects industry, and a credit to directors willing to consider new cinematic techniques. “Clint has been making movies for some time,” Owens said, “and he’s always as fresh as a daisy as far as being open to new ideas. He’s a great man and has a great mind. Another wonderful thing about Clint is that he never acts like a kid in a candy store when it comes to effects. He’s never been one to say: ‘Well, we can do it, so I’m going to have 15 dinosaurs run through the frame. It has nothing to do with the story, but it’ll look great!’ He’s never done that, and he never will.”

In addition to the satisfaction of working with Clint Eastwood on *Changeling*, Owens enjoyed one of the less-discussed benefits of doing effects in the digital age. “I live in Idaho,” Owens concluded, “and



In addition to extending the backlot street, the effects team replaced many of its most recognizable buildings with CG structures. The reconstituted street figures in the film’s two- and-a-half-minute-long end credits shot – a high-angle view of downtown Los Angeles with many cars and people moving through frame. CIS Vancouver filled the extended shot with synthetic buildings and traffic, and – to augment extras in the original plate and correct some mistimed action – blended Massive characters into a clean street plate.

the wonderful thing that has happened over the last couple of years is that you can work from a place like Idaho. For *Changeling*, I worked out of my house for about half of the postproduction period, and it was an incredibly productive way to work. Keep in mind that for this to be efficient everything and everyone needed to be pretty buttoned up technically, artistically and workflow-wise — but once we were, man, what a difference that made! And when working with multiple visual effects facilities in different places on the planet, it's incredibly efficient. I moved up here several years ago, expecting that I would have to do a lot of traveling. Instead, I have been very pleased — and a bit shocked — to see how well this remote setup works.”

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Summoning the Spirit

image

Article BY George MoïSe

When Frank Miller was a young comic book fan, enraptured by the derring-do of Will Eisner's iconoclastic comic book *The Spirit*, little did he dream that one day Eisner would become his mentor and friend. Still more out of his grasp was the notion that he would one day write and direct a film adaptation of Eisner's pioneering strip.

The Spirit chronicles the exploits of a rookie cop, Denny Colt (Gabriel Macht), who has returned from the dead as the masked vigilante known only as the Spirit to fight crime in Central City. "In the true tradition of Will Eisner," asserted senior visual effects supervisor and second-unit director Stu Maschwitz, "the Spirit is a flawed, imperfect hero. And he is not a superhero. He doesn't really have any special abilities — other than being back from the dead."

Following the lead of *Sin City*, which Frank Miller co-directed with Robert Rodriguez, *The Spirit* used an almost entirely greenscreen approach. Most often, Miller shot only the actors and minimal props; and then, in postproduction, visual effects artists filled in the greenscreen matte areas with completely digital city environments. "The reason this needed to be a greenscreen movie," Maschwitz noted, "was not because we were going to create impossible environments, but because it freed us up to do what Frank does in his comic work — which is only include something if it helps to tell the story. A filmmaker is doomed to show too much, to point his cameras at not only the part of the shot that's telling the story but at a bunch of stuff in the background that isn't. But a comic book artist can draw only the critical parts, and leave everything else out. By doing this as a greenscreen movie, we could do the same thing."

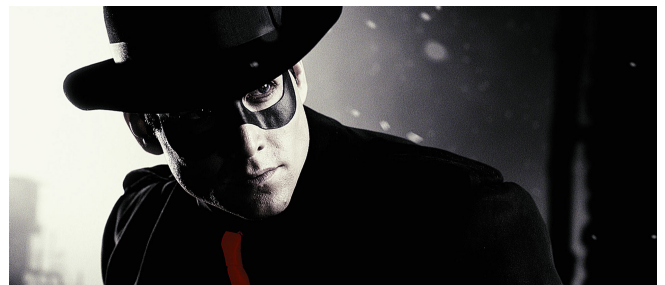
Maschwitz — who had worked on *Sin City* — came onto the production while it was still in its preparation phase, working alongside visual effects producer Nancy St. John. Also brought on early was director of photography Bill Pope who, with Maschwitz and Miller, developed the film's minimalist style. "There were early conversations between myself, Bill and Frank about using silhouette and minimalism to create strong iconic images," said Maschwitz, "and Bill's just a natural at that. He understands that sometimes you can see an actor's performance better if you only see half of his face. And that is similar to Frank's artwork. He manages to show you so much by showing you so little." But while *The Spirit* would be stark and minimalist in style, Miller had no interest in merely transplanting the comic book images to the screen, as Robert Rodriguez had essentially done on *Sin City*. "What quickly emerged out of the conversations between Bill and Frank and myself was that we were all interested in making a movie, and we agreed that we should achieve the Frank Miller look using cinematic tools. We wanted *The Spirit* to have a photographic look and feel."

The Orphanage, in San Francisco, served both as effects vendor on the show and as a base of operations for Maschwitz and St. John as they shepherded visual effects shots through facilities that also included Digital Dimension, Fuel VFX, Furious FX, Riot, Entity FX, Look Effects, Rising Sun Pictures and Ollin Studios. At *The Orphanage*, Maschwitz and St. John set up what they called 'the

bunker,' so named due to its location in a repurposed military building at the Presidio. "The bunker was a hub of visual effects management, plus digital intermediate," said Maschwitz, "and it was a key aspect to our being able to do 1,900 shots in six months with ten vendors. I was able to give the vendors information I'd always dreamed of having as a vendor myself — everything from sample frames to sample Shake scripts and Nuke scripts to look-up tables representing the color correction that we were doing on a per-shot basis. The vendors were able to hit the ground running, get past the small technical hurdles, and spend every second of every day making creative decisions."

Effects shots were first conceived in storyboards drawn by Frank Miller. "These had to be some of the most beautiful storyboards ever made," Maschwitz said. "Each one was 11-by-17-inches, inked and gorgeous. From those, we came up with seven or so sequences that we felt should be fleshed out in previz, and that was handled at *The Orphanage*. We limited ourselves to the action scenes and those that would rely most heavily on digital environments, cutting them together in a story reel and doing traditional 2D After Effects cutout animation. Eventually, we brought on a team of animators and started to do more traditional 3D previz — but it was always a hybrid. We generated some simple 'toon' shaders in Maya that allowed us to do high-contrast black-and-white renderings for the 3D animatics that mimicked the Frank Miller inking style and cut in better with his drawings."

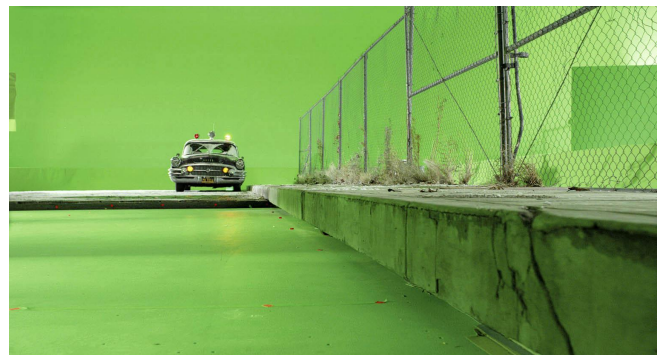
Using Panavision Genesis high-definition cameras, Miller shot *The Spirit* at Albuquerque Studios in New Mexico, on two adjoining stages. Production decked out one stage with 360 degrees of greenscreen, while the second stage was half green and half black. Art department crews built minimal set pieces on the studio stages, mostly limited to those with which the actors would come into direct contact. "There was one shot in *Sin City*," Maschwitz recalled, "where Bruce Willis pounded his hands on the pavement, inches away from the lens — and it took us more time to make that pavement look realistic than it did to create the backgrounds for the entire sequence! That was a lesson that I took into this. Floors were particularly important. If the camera was going to be on a wet cobbled street, I wanted to have some practical representation of that. But we also built entire sets for some scenes, where only the view out the window was greenscreen."



Based on the classic comic book series by Will Eisner, *The Spirit* chronicles the exploits of rookie cop Denny Colt (Gabriel Macht), who returns from the dead as the Spirit, a masked vigilante bent on fighting crime in Central City. After co-directing the film version of his own *Sin City* graphic novels with Robert Rodriguez, comic world icon Frank Miller made *The Spirit* his solo directing debut. Rather than exactly replicate comic book panels, Miller aimed to give his adaptation a cinematic, film noir look and tone.



Visual effects supervisor Stu Maschwitz and visual effects producer Nancy St. John delivered the film's 1,900 effects shots in only six months. Key to the project was the establishment of 'the bunker,' a central hub of visual effects management and digital intermediate from which Maschwitz and St. John oversaw effects shots contributed by The Orphanage, Digital Dimension, Fuel VFX, Furious FX, Entity FX, Riot, Look Effects, Rising Sun Pictures and Ollin Studios. Fuel delivered 44 shots for an opening titles sequence in which the Spirit pursues criminals through the streets and across the rooftops of Central City.



Using high-definition cameras, Miller shot *The Spirit* at Albuquerque Studios, on two adjoining stages: one with 360 degrees of greenscreen, another with both green and black backings. Revisiting filming methods developed on *Sin City*, Miller took a minimalist approach to the shoot, photographing actors on partial sets and relying on the visual effects team to fill frames with noir-ish environments, lighting and atmospherics. Digital Dimension computer generated an extensive environment and falling snow – a ubiquitous feature in the movie – for an early shot of the Spirit in a hijacked police car.

The stunt crew rigged the greenscreen stage with a fixed trellis rig to accommodate the show's extensive wire work, required for scenes in which the Spirit or other characters executed dynamic fight moves or leaps between buildings. "Frank was quite adamant that there not be any digital doubles in this movie," noted Maschwitz. "Everything was done by real performers and stunt people; and so we needed a quite extensive wire setup. Because it was permanently fixed, we could bring the sets to the stunt rigging instead of the other way around, and we were always rigged up for any kind of crazy wirework."



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Devoid of super powers, the Spirit fights Central City's criminal element with the aid of urban props such as manhole covers, streetlamps and garbage containers. For a shot of the Spirit depositing a mugger into a trash can, production captured the action on the greenscreen stage. Ollin Studios built the surrounding alley environment and used the live-action greenscreen element to create shadow characters in the final shot. The image was illustrative of Miller's intention to pay homage to the movie's comic book origins by designing shots that were suggestive in nature, revealing only what was vital to the story.

During the shoot, the production team enjoyed the benefits of on-set color correction, worked out in a series of test shoots conducted by Maschwitz and Bill Pope. Though the crew was recording uncorrected Panalog to tape, the image on the high-def set monitors was color-corrected by way of a look-up table; and, as a result, every department head, from makeup to wardrobe, was able to preview how his work would look when the movie was screened in theaters. “That look-up table traveled with us through to post and was shared by all the vendors to ensure consistency,” Maschwitz stated.

The Spirit's opening title sequence, in which the Spirit runs through the streets and across the rooftops of Central City, fighting the city's criminal element, sets up the visual style of the film. Working from previz by *The Orphanage*, Fuel VFX delivered 44 shots for the sequence, creating environments and building cityscapes often kluged together from stills Stu Maschwitz had shot in New York. Fuel's virtual sets were fleshed out only to the degree needed to tell the story. “There was a stylized look to all the shots that came from working with shadows and the way light hit certain parts,” said Fuel visual effects supervisor Dave Morley. “If there was a brick wall, we didn't need to build the whole wall. There could be a little speck signifying ‘brick,’ and then those 40 pixels would tell you that the other 300 pixels were brick.”

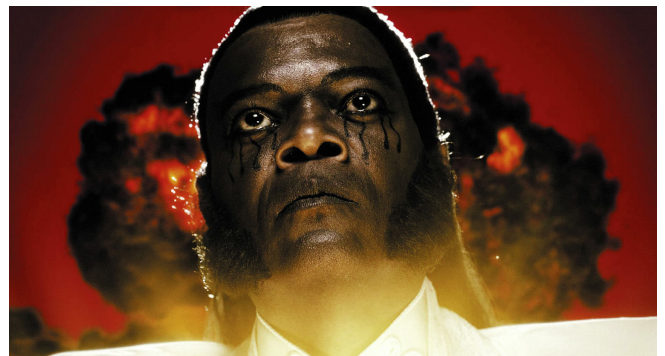
In one Fuel shot, the Spirit jumps through the air, does a somersault, lands atop a water tower, slides down the side and drops down into the city. Maschwitz shot Gabriel Macht's stunt double executing the move. “That was all done in-camera, on a slippery double ramp erected about 20 feet in the air,” said Maschwitz. “As the Spirit runs up the side of the water tower, he stumbles a little bit. It was important to Frank that the Spirit not do this move perfectly. Then he slides down, off the side of it. We did about 30 takes to get the shot just right.”

“That was probably the most challenging shot of the sequence for us,” added Dave Morley, “because of the camera move at the start that we had to meld into the live-action. But that ended up being one of Frank's favorite shots.”

The opening titles segue to a sequence in which the Spirit makes his way to the Mudflats where, he has been informed, something is going down with his arch-nemesis, the Octopus (Samuel L. Jackson). *The Orphanage* created 3D and 2D environments for the



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A shot of the Octopus (Samuel L. Jackson) – a scientist and the Spirit's arch nemesis – against the backdrop of a nuclear explosion broke with the film's predominant

sequence. “Stu, as second-unit director, shot a lot of that sequence,” said Orphanage visual effects supervisor Rich McBride. “There were little pieces of set in those shots — a bit of a brick street, a manhole cover, a chimney, and a fire escape where the Spirit fights a couple of bad guys. We extended those set pieces to complete the shots, basing our work on storyboards and artwork created by concept artists here at *The Orphanage* and with the production.”

visual style, and instead suggested manga and animé action sequences. After scouring stock footage for an appropriate mushroom cloud image, Rising Sun Pictures, which realized the shot, composited a 3D explosion rendering using Shake. Rising Sun also animated subtle highlights on Jackson’s pupils to create a quivering eyeball effect often seen in animé.

From a rooftop, the Spirit witnesses a woman being mugged in an alley below, and then dives down the side of the building to confront her attacker. Ollin Studios, supervised by Charlie Iturriaga, handled the shot, starting with plates of a stunt double on wires, shot at 300 frames a second. “We removed all the wires,” said Iturriaga, “and generated a full CG background for the buildings and the clouds in Mental Ray and Maya so we could make it look like he was flying. We also created a CG version of the alley, adding CG walls, pipes, stairs and windows.”

Continuing toward his destination at the Mudflats, the Spirit lands on the roof of a squad car, driven by a police officer played in a cameo by Frank Miller. *The Spirit* pushes him out of the car, and then takes the wheel and drives away as the camera cranes up to reveal several city blocks. Furious FX, under Kevin Lingenfelter’s supervision, realized the wide view, creating city streets that failed to converge in a straight line, as per Miller’s and Maschwitz’s instructions. “Things were bent ever so slightly to give it character,” said Lingenfelter. “It took the curse off of too clean or pristine CG. We tilted some of the buildings as well, very slightly. When Frank saw it, he said, ‘That’s Central City.’”

The Spirit arrives at the Mudflats, revealed in a wide establishing view that was one of the show’s most difficult shots, requiring nearly the entire postproduction schedule to complete. “It involved a lot of work in terms of CG elements, 3D environments and compositing,” recalled Marc Morissette, compositing supervisor at Digital Dimension, which handled the 175-shot Mudflats sequence. “We occasionally had to replace the greenscreen set — the ground — with a CG set, and have all the elements track together so the camera movement was perfectly matched to the set camera.”

At the Mudflats, the Spirit discovers a wounded police officer, whose shooting by the Octopus we witness in a flashback sequence. The flashback also reveals the Octopus fighting with the Spirit's ex-flame, Sand Saref (Eva Mendes), and her husband (Eric Balfour) over two underwater treasure chests. In second unit, Stu Maschwitz shot the underwater scenes dry-for-wet, and then delivered the plates to Riot for the building of environments. "Stu was absolutely genius in how he shot this stuff," recalled Riot visual effects supervisor David Jones. "For example, for a shot of Sam Jackson swimming toward camera, Stu sat him on a little bicycle seat stool, the camera directly above him, and then lowered the camera. He was looking straight up as the camera was moving down, and it had an extra inverted gravity feel that you get underwater because the shot was flipped." To help sell the underwater illusion, Bill Pope shot a fair amount of interactive lighting on the day and cleverly placed lights to create a ripple effect. "Frank wasn't going for an absolutely real underwater look, because, honestly, underwater things aren't terribly attractive. Our job was to create an idealized underwater look."



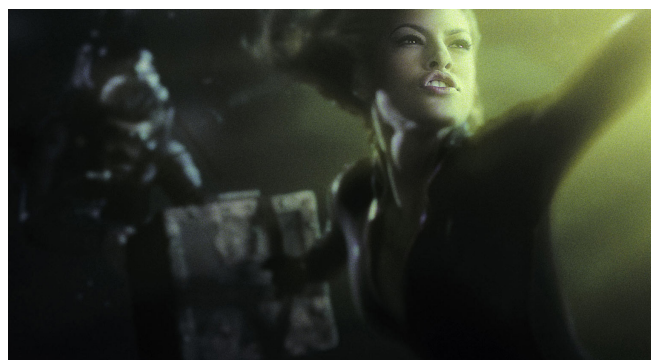
In his laboratory, the Octopus – with a trio of cloned henchmen (Louis Lombardi) and cohort Silken Floss (Scarlett Johansson) – examines a foot with a tiny clone head attached, the result of a spectacularly failed genetic experiment. To guide the actors' eyelines on set, Nancy St. John moved a tennis ball on a stick across the lab table during the live-action shoot. The Orphanage replaced the tennis ball with the foot creature, tracking 2D footage of Lombardi's head – shot at three different angles – to a 3D foot animated in Maya.

Back in the present, the Octopus drags one of the chests out of the mud, and then orders Pathos, one of his cloned henchmen — all portrayed by Louis Lombardi — to take it and wait for his partner in crime, Silken Floss (Scarlett Johansson), who arrives in a truck and absentmindedly runs over the dimwitted clone. Production shot a plate of the truck driving in and then, separately, a plate of Lombardi miming the impact of the truck and being thrown out of frame. Furious FX re-animated both the truck and the actor. "We had to re-animate the actor's mimed action because it wasn't quite forceful enough," noted Kevin Lingenfelter. "And we had to re-animate the truck because, since it hadn't really impacted anything, it was missing shock effects." For a shot of the henchman under the truck, Furious FX stabilized a stand-alone tire situated on the actor in the plate. "You could see the tire moving up and down more than it really would have if it had been attached to a heavy truck; so we had to lock it to the actor."

Silken Floss grabs the chest, corrals the remaining henchmen, and drives off. Furious FX rotoscoped the truck out of the plate, separating it from the ten crew members who had pushed it through frame, and then added a textured 3D plane of ground. Furious also generated trees and brush to create the background environment. "We peppered the whole background with several hundred trees," observed Lingenfelter. "We also added moonlight, a God-ray effect in Nuke streaming through all the tree layers. At the 11th hour we added the truck headlights, which were off when they shot the truck."



In a flashback sequence, the Spirit's ex-flame, Sand Saref (Eva Mendes), and her husband Mahmoud (Eric Balfour) retrieve an underwater treasure chest. As second-unit director, Stu Maschwitz shot the sequence dry-for-wet against greenscreen, with the actors attached to wire rigs to simulate a zero-gravity underwater environment. Director of photography Bill Pope helped to sell the illusion with cleverly placed lights suggesting a ripple effect. In postproduction, Riot digital artists created an idealized underwater environment, which – unlike authentic underwater photography – retained the highlights and contrasts in the original plate.



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The Spirit and the Octopus engage in a mud fight, the look of which exemplified the minimalist photographic style of the film. “The characters are coated with this mud,” said Stu Maschwitz, “and often the background behind them is pure white. It’s nighttime, foggy and snowing; so the big light that is rim lighting the characters is blasting through a lot of atmosphere. As a result, the edges of the characters become indistinct, blending into a pure white background. That is very much a Frank Miller-ish kind of image, where only the jaw line or an eye socket of a face remains. Everything else is bleeding away, and you’re reducing the image down to the bare essentials.”

Digital Dimension created virtual environments for the extended mud fight. “What was challenging about it,” observed Marc Morissette, “is that the fight moves from one place to another. They start fighting at street level, so there were digital buildings and set extensions we had to do for that first part. And then it moves into a muddy area in the woods, which we digitally re-created using matte painting and CG elements. At the end of it, the action occurs next to a big body of water. So we had to do a lot of different backgrounds for this fight, and through it all there was fog and snowfall, which we added digitally.”

Snow was a ubiquitous feature in the film, requiring every vendor to devise a way to create snowfall for its shots. “In Sin City,” said Look Effects visual effects producer Melinka Thompson-Godoy, “Stu Maschwitz had perfected the art of snow in this type of world. The goal on this movie was photorealism, but with style.”

Look Effects used Maya and After Effects particle systems to generate separate background, midground and foreground layers of snowfall, creating a sense of depth. “The depth of field on the snow was something we paid close attention to,” stated Look visual effects supervisor Max Ivins. “We had to make sure every single snowflake behaved photorealistically.” Look executed a split diopter shot



In a flashback montage, the Spirit recalls his youthful love affair with Sand Saref. One sequence has the pair hitching a ride on a subway train, Sand exhibiting her joie de vivre as she hangs off the rear of the speeding car. Production shot the young Denny and Sand actors – Johnny Simmons and Seychelle Gabriel – on a train car set piece, which Furious FX re-skinned with a CG version. Furious also added buildings sweeping by as the train moved through the heart of Central City, and detailed some structures with graffiti. Fog and other atmospheric effects completed the shot.



In a flashback montage, the Spirit recalls his youthful love affair with Sand Saref. One sequence has the pair hitching a ride on a subway train, Sand exhibiting her joie de vivre as she hangs off the rear of the speeding car. Production shot the young Denny and Sand actors – Johnny Simmons and Seychelle Gabriel – on a train car set piece, which Furious FX re-skinned with a CG version. Furious also added buildings sweeping by as the train moved through the heart of Central City, and detailed some structures with graffiti. Fog and other atmospheric effects completed the shot.

— with the snowflakes changing their focus as they crossed the center of frame — for a shot of the Octopus and Pathos on a street. “A split diopter allows you to focus one part of the frame differently than the other. That creates a line through the frame; and as something crosses that line, the focus changes. Working to make sure we stayed true to the diopter was just one example of the attention to detail Frank and Stu expected on the film.” Look also created the virtual street environment surrounding the Octopus and his henchman.

In a Furious FX sequence dubbed ‘flashback walk,’ the Spirit takes a walk on a brick embankment along a cliffside to reminisce about Sand Saref. “They had built the brick wall, but that was it,” explained Kevin Lingenfelser. “We modeled part of the cliffside, as well as a lighthouse with a rotating light that periodically wiped through frame and lit up the area. They did some interactive lighting on set, but we had to enhance that to make the light gag work. We also added snow and fog that was a combination of fluid dynamic stuff generated in Maya and some 2D practical smoke elements.”

The flashback includes scenes of young Denny Colt and Sand Saref on the back of a subway car racing through the city, Denny holding onto the train with one arm, and onto Sand with the other. Production originally filmed two young actors on a partial mockup of the train car, which Furious FX later re-skinned digitally. CG supervisor Mark Shoaf was instrumental in creating buildings passing in the distance. “Stu and Frank wanted it to be in the heart of Central City,” stated Lingenfelser, “so there were a lot of warehouses and water towers. The backgrounds were atmospheric, bathed in gold light. We added a lot of fog and weather effects into the background, as well as some graffiti on the buildings.”

Later in the flashback scene, the characters pass a jewelry store and Sand becomes transfixed by the riches inside. The only live elements in the shot were the two actors, plus some background extras walking by. Furious FX comped in an entire city street and additional couples walking hand in hand. Inside the jewelry store, a salesperson in black silhouette walks by wearing a pearl necklace, the action serving as a wipe. “This was handled as a very graphic element,” said Lingenfelser. “We made the woman completely black, and the pearl necklace stark white.”

The wipe transitions to Sand and Denny sitting on a spiral staircase, reading comic books. “We had to extend the staircase because it was only a partial build on set,” said Lingenfelser. “We went very graphic with that, as well, with a lot of gobos to darken the bottom three-quarters of the frame. We made the top of the stairs pop with some powerful rim-lighting.” The flashback sequence ends with Denny and Sand sharing their first kiss under a doorway in the middle of a torrential downpour. The camera then travels up the side of the building to reveal a Furious FX Central City skyline, complete with omnidirectional rain comprised of practical and CG elements.

At the urging of his present-day love interest, Ellen Dolan (Sarah Paulson), the Spirit gets a checkup at the hospital — a synthetic environment created by *The Orphanage*. “It was very cool to lay in this stylized environment that looked like a hospital, yet still lived in the Spirit world,” said Rich McBride. “We did one exterior shot as a matte painting, and then there was some pretty straightforward compositing, adding people into hospital hallways.”

Given a clean bill of health, the Spirit leaves the hospital, arguing with police chief Dolan (Dan Lauria) as they move through a completely simulated environment of taxi cabs, people, birds, elevated trains and more. Dubbed ‘walking and talking,’ the sequence was handled by Look Effects. “That was our busiest daylight exterior dialogue sequence,” said Stu Maschwitz. “The characters were turning corners, walking down alleys, dodging out of the way of taxi cabs, all in broad daylight. Peter Lloyd, at *The Orphanage*, created concept pieces for each shot in the sequence, which he then fleshed out into high-rez matte paintings for Look to map onto their 3D scenes.”

The sequence was one of the most challenging of the show, for a variety of reasons. “The actors were shot on an indoor stage that needed to be integrated with an all-CG outdoor environment,” noted Max Ivins. “There were a lot of Steadicam shots, which required 3D camera matching. Totally green backgrounds are challenging because 3D tracking software needs a lot of points to solve the camera position, but in a greenscreen stage, you’re devoid of natural tracking markers. Production put laser dots around the set, but the software needed more points than was really practical to provide on set.” To augment the laser dots, Look relied on slight imperfections in the greenscreen. “We created a process to isolate subtle imperfections and details in order to create additional points for our 3D camera tracker. That worked for about 80 percent of the shots.”

For most of the ‘walking and talking’ environments, Look mapped matte-painted elements onto three-dimensional shapes and surfaces built by 3D supervisor Michael Capton and his team. “As part of our attention to detail, we also added animated CG cars and other items into the scenes,” observed Melinka Thompson-Godoy. “We added an elevated 2D train going by in the background. We created a zeppelin, too, which we initially just threw in for fun; but then, once it lived in the scene we had to make it look perfect, with the appropriate lighting and everything.” To add more life to the background, Look also comped in people shot as live elements on stage.



In one of the show’s most complex sequences, the Spirit and Police Chief Dolan (Dan Lauria) engage in spirited discourse as they walk through downtown Central City, turning corners, crossing streets and dodging cars and pedestrians. The filmmakers shot the extended, intricately choreographed sequence with a Steadicam, on a nearly bare greenscreen stage, projecting laser dots to help the visual effects team at Look Effects execute 3D camera matching in post.

At the end of the sequence the Spirit and Dolan go into an office building and ride an elevator. “We built the entire elevator shaft and the pipes that go by in Maya,” said Max Ivins, “with additional enhancements in After Effects. As a joke and homage to the Spirit’s love of cats, our artist threw a cat in there, and Stu and Frank fell in love with it.”

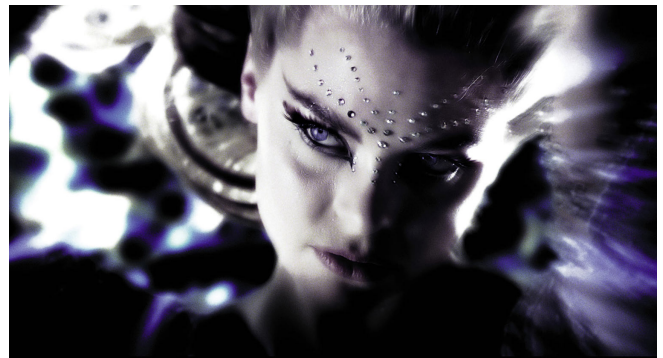
Back at the Octopus’ lab, he and Silken Floss marvel at one of his genetic experiments gone awry: a human foot with a tiny clone head on it. *The Orphanage* created the 3D character. “The foot creature was a very last-minute thing,” recalled Rich McBride. “They hadn’t planned for it, and so they had to work out how they were going to fit it into the scene. Stu came up with the idea of shooting it from more or less one camera angle, with Sam Jackson sitting at the table watching this thing — which was actually a tennis ball on a stick that Nancy St. John, off to the side, hopped across the table. Separately, they shot the actor who plays the tiny head at a three-quarter angle and at a profile, left and right. Then, we took that 2D plate and attached it to a 3D foot in Maya.”

Determined to confront Sand Saref, the Spirit hitches a ride atop a semi-truck passing through a tunnel and into downtown Central City. “The sequence starts with one of the most challenging — if not the most challenging — shots we had to do,” stated Riot’s David Jones. “They shot the Spirit on a green pad with some beautiful interactive lighting and the camera swooping around him. We then had to surround him with an entire world. And, because it was a continuous shot, this world needed a road system that worked, that could carry him from point ‘A’ to point ‘B.’ To keep it interesting, so it wasn’t just silhouetted buildings with no sense of real space, we had to put in an immense amount of detail. We weren’t just building architecture; we were actually populating the rooms of the buildings. That one shot took most of the duration of the show.”

Production concept artist Aaron Simms provided Riot with some initial shot designs, and also matte-painted distant buildings and a sky to back the 3D work. A foreground layer of buildings consisted of photographs and lidar scans of structures in New York. “Frank had a very set idea of



Digital artists at Look Effects created exterior daylight environments for the walking and talking sequence, tracking in CG foreground structures, distant cityscapes, alleyways, vehicles, elevated trains and birds flying in the sky. For some shots, Look also composited in live-action elements of passers-by. To augment the on-set laser dots and provide its 3D camera-tracker software with sufficient tracking points, Look artists isolated and tracked slight imperfections in the stage greenscreen backing.



Stabbed by an ex-lover, the Spirit falls from a dock and into a body of water, where he encounters Lorelei (Jaime King), the diaphanous spirit of death. To create the surreal underwater scene, Riot started with high-speed production plates of King and Gabriel Macht hanging from wires. Riot darkened the cloth portions of King’s costume, and then extended and replicated its strands of sequins in CG, using an After Effects plug-in to generate wireframe coils. Riot manipulated the strands to act as tentacles that encircle the Spirit and pull him deeper into the water to his second demise.

what Central City looked like,” Jones explained. “He wanted it to be evocative of New York, but without New York landmarks.” Riot engaged a New York firm to photograph specific areas of the city, and from those photographs reconstructed 3D New York streets, minus the most recognizable buildings. “We would take a famous building, and build the one next to it. So the buildings around the Chrysler Building were well represented, but not the Chrysler Building itself.”

Following his confrontation with Sand Saref, the Spirit makes his way to the Octopus’ factory hideout, guarded by the villain’s clones. While fighting them off, he grabs a manhole cover and flings it like a Frisbee at one of the henchmen, slamming him into a brick wall. *The Orphanage* added dynamic impact to the shot. “We had a plate of one of the stuntmen with a manhole cover attached to his stomach,” said Rich McBride. “They shot it overcranked, and he hit a soft, pillowy wall and bounced off. It didn’t look at all menacing, so we had to re-create that action, pulling frames out of the plate to get a good impact as he hit the wall.”

Having finished off the henchman, the Spirit flips backward up to the roof of the factory and sneaks in.

“We had a shot of an acrobat doing this move on a level floor,” noted McBride, “and we had to rotate it around, and then create a camera move out of it. So it became this combination 3D/2D shot to make it look believable as he propelled himself up the building. It ended up being a really cool shot, with silhouettes and the cityscape off in the background. That was all matte painting projections on cards that were built in Nuke.”

After being captured by the Octopus, the Spirit escapes with the help of Plaster of Paris (Paz Vega), a murderous belly dancer with whom he once had an affair. No sooner is he free than Plaster impales him with a sword. *The Spirit* stumbles to the docks and falls into the water, succumbing to his second demise. The dirty, dense underwater world changes to a surreal landscape when the Spirit encounters the diaphanous ‘spirit of death’ Lorelei (Jaime King). Production shot King and Gabriel Macht hanging from wires, high speed, and then Riot completed the sequence. “The costume designer put Jaime in this wonderful costume that had strings of sequins in organic patterns,” recounted David Jones. “We darkened down most of her costume and kept the string of sequins, which cast light and circled around the Spirit, dragging him to the other world.” To create that other world, Riot employed an After Effects plug-in called ‘Form.’ “It generates these arbitrary, synced wireframe environments. We played with the Form plug-in until we got these coiled strings to move in the same manner as her hair, coming out and surrounding her and Gabriel.”



The action climaxes with a showdown between the Octopus, Central City police and the re-resurrected Spirit at the projects, an abandoned inner-city construction site. Fuel contributed 165 shots to the finale, including an all-CG shot of Sand Saref flying into the projects to rendezvous with the Octopus and Silken Floss. Fuel designed the gritty, derelict look of the projects, and then built all of its structures as 3D models. The Fuel shots also featured volumetric clouds and snowfall generated via Maya particle simulations.

The Spirit returns for the movie's finale, which begins with Sand Saref flying into the projects to meet the Octopus and Silken Floss for a hand-off of their respective treasure chests. Fuel created both interiors and exteriors for the shot. "The exterior shot of the plane flying over the city was fully generated and a pretty massive build," said Dave Morley. "We created the city, volumetric clouds and a lot of snow, which was all done with Maya particle sims. It was one of the more fun shots for us because we were given the reins to come up with a camera move and whatever would make it look cool."



Fuel shared its CG projects assets with Entity FX, which handled the second half of the finale. Working with plates that consisted only of actors in a sea of green, Entity first oriented the characters in their environment by building cameras in Maya for every shot, derived from on-set camera data, and placing characters within rough 3D sets. For specific architectural features, such as front stoops or doorways, Entity matched drawings in Will Eisner's comic panels to model the 3D set pieces.

Fuel contributed 165 shots to the finale, establishing the look of the projects and completing shots for a standoff between Sand Saref and Silken Floss, and the 'High Noon' showdown between the Octopus and the Spirit. Fuel also developed the dramatic backlighting of the Spirit throughout the sequence.

Entity FX handled the second half of the projects finale, working with plates that consisted only of actors in a sea of green. "In order to get our heads around the sequence as a whole," said Entity visual effects supervisor Brian Harding, "we had to figure out where these characters were in this green world at any given point. I needed to know what was behind them when they turned screen right. Lead environment artist Kaz Yoshida took all the camera information from the set and built cameras in Maya for every single shot. And then we built a very rough 3D world with tracked cameras, which told us, 'Okay, at this point, the Spirit is standing on the northwest corner, ten feet from the Octopus; and when he looks up, helicopters are flying over a building that is three stories tall.' Once we built the world, we altered it as necessary because the sequence wasn't about being literal; but it offered a starting point, which Stu could sign off on for look and mood."

Based on the look developed by Fuel in the first half of the sequence, Entity's 3D projects environment was a bleak, abandoned area, still under construction. "It was important for Stu that it didn't have a beautiful comic-book city look," said Harding. "Also, in building the environment, I wanted to use as much of Will Eisner's iconic objects as possible. When we had to build a stoop, I would go to a Will Eisner book and find a panel of a stoop and have the Maya artist literally model that." Kaz Yoshida modeled the 3D elements based on tone paintings that matte painter Jason Dunn created for every shot. "We would take the rough geometry, say a street going back into the horizon line, and instead of just presenting a cold geography of a street, we would paint splotches of color, dropping in splashes of lights and darks behind the comps to get a sense of what the shot would feel like. The comp with the final CG had a lot of detail that you could sometimes barely sense through the smoke and mist; but it allowed us to balance the gritty with the fantastic."

Entity added snowfall to each of its shots, generated through an in-house software called Frosty, developed by David Alexander. The visual effects team also layered in practical smoke elements shot by Stu Maschwitz, for shots after the Spirit and Central City's police force arrive at the projects and fire on the Octopus. Entity placed the practical smoke elements in 3D space via After Effects. The shots also included 3D squad cars and CG Apache helicopters attacking the Octopus, who finally meets his end when the Spirit slips a grenade down his pants. CG artist Junji Hirano used Maya to create the resulting explosion, complete with flying 3D body parts, particles and simulated cloth. Compositor Dan Blank composited the shot in After Effects.



In an Entity shot, the Octopus fires on a police helicopter during the projects sequence. Entity matte painters created tone paintings for each finale shot, adding splashes of highlights and shadows to 3D modeled elements. Details in the 3D environments were often obscured in final composites by large volumes of smoke, mist and snowfall. Entity placed practical smoke elements into its shots via After Effects, and generated snowfall through its in-house software, Frosty.

Due to the unique organizational features of the bunker, Stu Maschwitz, Nancy St. John and their vendors delivered *The Spirit's* 1,900 effects shots with exceptional effectiveness and efficiency. "It was a luxurious work environment, from my perspective," Maschwitz concluded. "I didn't work long hours, I didn't work any weekends, and I spent every minute of every day making creative decisions. Integrating the DI process with the visual effects review process created an amazing efficiency in terms of getting the shots pumped through — our peak week we had 451 high-rez finals, which may be a record. Just as important, though, it paid dividends in terms of the creative relationships with the vendors, because we were always moving forward. Day in and day out, it was the most fun I've ever had going to work because it was a 100-percent creative process. All credit goes to Nancy St. John for putting together the most rock-solid visual effects production I've ever been a part of."

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A Handmade World

Article by Joe Fordham

Like Alice in Lewis Carroll's *Alice's Adventures in Wonderland*, the title character of Neil Gaiman's 2002 novella *Coraline* is a restless child whose imagination and inquisitive nature lead her to discover a world beyond her humdrum existence.

Gaiman's heroine — inspired by the author's interactions with his own young daughters — is dissatisfied with her parents' preoccupation with their writing careers. She finds escape by venturing through a hidden doorway in her living room wall into an 'Other World' where she discovers a mirror image of her home inhabited by more attentive parents, albeit with large black buttons sewn into their eyes. As with all good fantasies, a cautionary tale lies within, as *Coraline* discovers her Other Mother's ambition to make her a permanent addition to the button-eyed world.

The surreal nature of Gaiman's story appealed to filmmaker Henry Selick, who displayed a similar sweetly sinister sensibility in his stop-motion animated films *The Nightmare Before Christmas*, *James and the Giant Peach* and *Monkeybone*. Selick developed a screenplay adaptation and proposed the project as an animated feature to Bill Mechanic, one of the film's first producers. "Bill's deal at the time only allowed him to do live-action," Selick recalled, "but I felt the story might be too dark if it was shot live. I felt that animation — in particular stop-motion — had a certain charm, and yet also could be quite creepy. There was a lot of odd stuff in this story, and I felt that stop-motion would soften some of the scares, while making *Coraline*'s world feel strange and different. Stop-motion is a powerful medium that barely has been used to make feature films, and I felt we could use it in a way that it had never been used before."

Selick was still considering prospects for realizing *Coraline* as a stop-motion feature when he joined the Laika animation studio in Portland, Oregon, as supervising director in 2004. The studio at the time was transitioning from its work as Will Vinton Studios producing claymation, hand-drawn animation and computer graphics for television, commercials and music videos, and was interested in exploring longer storytelling formats. Selick and Laika first collaborated on an eight-minute animated short film, *Moongirl* — the first computer generated experience for both parties — which became a springboard to future projects. "I agreed to do *Moongirl* on the condition that I develop *Coraline* as a stop-motion feature," explained Selick. "As we were working on the CG short, and Laika was looking for its first feature film, we decided to do a test for *Coraline*. My thinking was that there were two worlds in the story — *Coraline*'s world, and the better version of her life that her Other Mother created — so I thought maybe we could do one world CG, and one stop-motion."

Laika experimented with different combinations of techniques. "We were trying to find what best suited the film," remarked Travis Knight, who first worked with Selick on *Moongirl* and then went on to become one of five animation leads on *Coraline*. "The idea was that CG, because of its precision, might bring a certain sterility and coldness to *Coraline*'s world; whereas stop-motion

straddled the line between warmth and creepiness, with inanimate objects being brought to life. We did some tests that had a CG character going from a CG environment into a stop-motion world, with the CG puppet interacting in the stop-motion set with a stop-motion puppet. It looked pretty cool, but it lacked the visceral impact that we were hoping for.”

The animation test convinced the production to pursue a single animation medium. “I’ll be honest,” admitted Henry Selick. “After working on *Moongirl* and seeing everyone sitting all day at their terminals, I just wanted to get back to touching and lighting real things. The physicality of stop-motion became even more attractive.” To help articulate the story’s dimensional shift, Selick added a stereoscopic twist inspired by his friendship with the chief technology officer of Real D. “I’d been aware of the advancements in 3D photography through my friendship with Lenny Lipton for more than 20 years. I decided to use 3D to help differentiate between the worlds. *Coraline*’s life is bland, gray and flat, so I made rooms appear smaller, as if they had hardly any depth; whereas in the Other World we used 3D to make it feel as if it had more breadth.”

To explore visual concepts for *Coraline*’s two worlds, Selick invited Japanese graphic illustrator Tadahiro Uesugi to produce conceptual art for the production. Uesugi’s renderings of elongated bodies and delicate color palette guided creation of the stop-motion puppets and environments. *Coraline* (voiced by Dakota Fanning) was envisaged as a skinny, blue-haired girl with brightly colored wardrobe that reflected her free-spirited nature and tomboyish traits. *Coraline*’s mother (voiced by Teri Hatcher) was a dowdy grown-up version of her daughter whose motion was impeded by a surgical neck-brace. Other Mother, by contrast, first appeared as more glamorous and stylish. Similarly, *Coraline*’s father (voiced by John Hodgman) was a bookish fellow with a sallow complexion, while Other Father was gangling and playful, with a lustrous hairdo.

The studio then held a ‘puppet summit’ to brainstorm construction techniques. “Merrick Cheney did a lot of our main armatures,” said puppet fabrication supervisor Georgina Hayns. “He and Anthony Scott — the head of animation — the costume designers, art directors and I met with Henry and discussed what he wanted, performance-wise, from his script and characters. Henry wanted to see a lot of movement in the hair and clothes. He didn’t want fabrics that were fixed onto foam sculpts; he wanted real cloth, and he wanted to see it moving. He wanted hair that looked like dolls’ hair that could blow in the wind, so *Coraline*’s hair had forward swing as she was walking, with little strands blowing about — it had to be very animate-able. That had never been done before in a stop-motion feature.”

Sculptors translated two-dimensional character renderings into clay maquettes. Laika then molded and cast rigid copies, which set-building and paint departments used for reference. Animators reviewed sculptures from an anatomical point of view, discussing potential armature designs and puppet gaits.

Laika then created neutral pose sculpts of each character as ‘break-aparts,’ designed to house custom-built metal armatures with ball-and-socket



The imaginative and feisty Coraline Jones longs for a world beyond her humdrum existence in the stop-motion fantasy, *Coraline*. Based on Neil Gaiman’s novella, and

joints and hinges that emulated skeletal anatomy. “We used the break-apart sculpt to work out what type of molds we needed,” related Hayns. “We studied what parts of the puppet were going to be costumed and which areas would need exposed skin. Hands had to be removable because they were always the first things to break during animation. We used male and female sockets, where the wrist attachment slotted into the female sleeve that had a tiny little screw going through it. We could unscrew that, pull out the broken hand and pop a new one in.”

Interspersed within the armatures were solid areas known as ‘grip blocks,’ designed to give animators safe purchase when manipulating spindly puppets. All puppet joints were tensioned to animators’ specifications using hexagon-head Allen keys. “Most of the joints were ball-and-socket with hexagon cap screws holding them together,” explained Hayns. “Each ball had two plates around it, and then we had a bolt that ran through the plates that we could use as a tensioning device. On *Coraline*’s wrist, the Allen key size was 0.80 — it was microscopic! We made seams in her costumes line up with Allen key heads. We’d make a little slit through the silicone, push in the Allen key, make the adjustment, and then glue it up for shooting.”

To animate characters’ faces, the production used two stop-motion animation techniques: mechanical armatures and replacement animation. “I have always used both approaches,” noted Henry Selick. “Some characters’ faces had mechanical parts, where underneath their silicone skin there was a moving jaw and moveable paddles that could shape their brows and lips. There’s a certain smoothness and beauty to that style of animation. For *Coraline* and most of the leads we went with more expressive replacement animation. That style of animation goes back to George Pal’s *Puppetoons*, *Speedy Alka Seltzer*, *Pillsbury Doughboy* — which I animated a bunch of in 1989 — and Jack Skellington in *Nightmare Before Christmas*. With replacements, you don’t get the smoothness of pushing rubber around; but you get very distinct, perfect expressions with the ‘snap’ that you get in the best 2D animation.”

Selick introduced an innovation to the replacement process, inspired by technology that he discovered while working with digital animator Martin Meunier on director Wes Anderson’s marine explorer drama *The Life Aquatic*. “The guy who owned the building where we rented offices was a technophile,” Selick recalled. “He bought one of the first rapid prototype machines, which translated digital models into real 3D objects. When we saw that, Martin and I immediately both thought: ‘How can we use this to help us in stop-motion?’” Meunier joined Selick in Portland as rapid prototype designer and, with Brian McLean as rapid prototype supervisor, installed

adapted, directed and designed by Henry Selick, the production marked the theatrical feature film debut of Laika, an animation studio in Portland, Oregon. The project reunited many of Selick’s prior collaborators including director of photography Pete Kozachik and supervising gaffer Bryan Garver, who had worked together on the 1999 film *James and the Giant Peach*. Selick’s team of animators, model builders and puppet makers brought the story to life in the first digitally photographed stereoscopic 3D stop-motion film. The team used a variety of puppets and props, including a miniature house and a large forest of pine trees and mountains.



Supervising gaffer Bryan Garver reviews a take as the motion control camera hovers above a miniature representing the Pink Palace apartments in gaudy *Other World* guise. Pete Kozachik’s camera team adapted Redlake Machine Vision cameras – commonly used for inspecting parts on assembly lines – to shoot stop-motion

three Objet Geometries stereolithography machines. Combined with Maya 3D modeling, the technology circumvented hundreds of man-hours of sculpting replacement faces in clay. “We worked out all the expressions with a really good 2D animator, first as drawings and then as sculpted key facial poses. We used a computer to help figure out some of the in-betweens, and then 3D printers output facial shapes.”

To multiply the expressivity of facial replacement pieces, the rapid prototype team bisected faces with a horizontal split across the bridge of the characters’ noses. This separated the upper part of the face from the lower portion, allowing the animators multiple permutations of expressions, while reducing the number of replacement pieces replicated by the fabrication team.

Replacement parts were first output in resin, then trimmed, primed and painted by a team of artists overseen by lead painter Cynthia Star. Facial shading was achieved by powdering onto the base color. To duplicate freckles in precise alignment on *Coraline*’s replacement faces, the 3D printing team output each freckle as a pin-head sized indentation. The freckles then absorbed a thin wash of paint that, when wiped with alcohol, retained residual paint.

Silicone supervisor Mark Thompson oversaw creation of puppet skins, favoring the pliability of silicone casting compounds over foam latex. “Silicone has revolutionized puppets,” said Hayns. “Until about ten years ago, most puppet makers wouldn’t use silicone because it was so hard to paint. You could paint it one block color, but you couldn’t paint any detail. I’ve worked with Mark Thompson for years now, and we’ve done a lot of experimentation painting on silicone. We’ve devised a technique using watered-down silicone pigmented with oil paint. We used toluene, which is toxic, as a solvent; and so it was important to take all the safety precautions and use extractors during the application. We found that when we used a solution that was not as toxic, it rubbed off.”

Hair and fur fabricating lead Suzanne Moulton realized puppet manes using mostly synthetic hair. “Suzanne laid strands individually onto puppet wigs and then laced in wires of the same color,” said Hayns, “which became an armature. She then applied a mixture of hair products, waxes and Prosaide prosthetic glue. It was a messy process, but it worked great. We made all our wigs in that style.”

To search for real-world fabrics that could be scaled to size, lead costume fabricator Deborah Cook and her team hunted suppliers in Los Angeles, San Francisco and London. “Deborah found some amazing commercially available materials,” remarked Hayns. “For *Coraline*’s jeans, for instance, we used a cotton shirt denim with a very fine weave that was perfect for our 1/6-scale puppet, nine and

animation. Cameras rode on custom motion control rigs with 12-foot tracks, 8-foot boom arms and pan/tilt/roll capabilities. To create stereoscopic effects, the camera first recorded an animation pose from the ‘left eye’ perspective, then slid via motion control to the ‘right eye’ position and shot the same pose again before returning to the left for the next animation pose.



Coraline puppets – nine and three-quarter inches tall – contained custom metal armatures with ball-and-socket joints rigged to simulate human anatomy. Exposed areas of skin were created out of silicone. Laika artists modeled Coraline’s facial articulation in 3D, then used stereolithography to replicate thousands of rigid resin replacement animation pieces, which adhered to the puppet heads with tiny magnets. Puppet hair was formed out of wire bound with hair products, waxes and prosthetic glue, teased into place frame by frame to simulate fluid interactive motion. Animator Chris Tootell

three-quarter inches tall. We tried to find materials that had enough stretch in them to flex with puppet motion.” Flowing fabrics were fitted with wire armatures, painted to suggest wear and tear, and custom-detailed to scale.

uses an X-acto knife to make a minute adjustment to Coraline’s hairdo.

While the puppet and set construction were underway, longtime Selick collaborator Pete Kozachik joined the production as director of photography. Kozachik’s first responsibility at Laika was to equip the studio with a digital camera system, catering to simultaneous animation on multiple sets with motion control and stereo capabilities. “I wanted to find a way to give the animators a high-resolution image to look at while they were animating,” Kozachik noted. “I found that most current high-definition television systems wouldn’t work for stop-motion. Instead, we went with a high-end Machine Vision camera made by Redlake, now marketed by Princeton Instruments.” Kozachik and his camera team adapted a camera used mostly for inspecting parts on assembly lines, and ordered the imaging systems with Bayer color filter grids on the image sensors.

The production also commissioned 11 custom-built motion control rigs capable of carrying cameras along 12-foot tracks, with eight-foot boom arms and pan/tilt/roll capabilities. “We built motion control rigs like the Japanese built their Zero airplanes in World War II,” Kozachik remarked. “We made a whole lot of them as simply as possible, knowing that the show needed a lot of rigs shooting at the same time, mostly doing basic camera moves. But we got the cameras to work both as the animators’ tool and a production camera. Our programmers wrote software applications that allowed animators to play back images in sequence in low-resolution black-and-white, or stop on a frame. The only drawback was that it took quite a while to write images to disk, because in filmic terms we were shooting the equivalent of an almost 4K image.”



Laika made use of its innovative stereo-lithography facial replacement technique for several key characters with extensive dialogue scenes. Resin outputs were mass-produced and hand painted by powdering onto the base color. Character painter Angela Kiely paints replacement faces for Coraline’s Other Mother.

To achieve the illusion of stereo perspectives — alternating images, polarized at plus and minus 45 degrees, viewed through glasses with similarly polarized right- and left-eye lenses — the camera used a single lens to capture dual perspectives of each puppet pose. “We lined up each shot through what we called the ‘left eye,’” Kozachik explained. “The camera was on a motion control axis that slid sideways. After the animator shot a frame, motion control slid the camera over to the ‘right eye,’ shot that frame and then slid back for the next pose. The art and the finesse of the system came with learning how far the little slider should go.”

The distance between right and left eye — the ‘interocular’ — was evaluated by projecting images in the Laika screening room. “We tested a lot of different interocular spacings projected as single frames,” said Kozachik. “We changed focal lengths, interocular spacing, and the distance of the subject to the lens to give us a number of variables. We then determined what looked correct for the curvature of a head, what looked more squashed or stretched out like a football. We learned the shorter the lens and closer the character, the less we needed to slide the camera to get a 3D effect.”

To assist placement of 3D effects, camera operators shot small targets — vertical lines on a flat disc the diameter of a ping-pong ball — in reference frames, which visual effects used to align right- and left-eye perspectives. “We shot both ‘eyes’ with their lines of sight in parallel,” observed visual effects supervisor Brian Van’t Hul. “We then did digital alignments, sliding the right eye from side to side in postproduction. The interocular distance, controlling how much depth we perceived, was baked into each shot. By sliding the left and right eye against each other, we could move that space toward or away from the audience.”

Van’t Hul — a veteran of the camera and lighting departments of Selick’s earlier films, and recently visual effects supervisor at Weta Digital — arrived in Portland initially to work on Pete Kozachik’s camera team. When bids from outside visual effects contractors proved more costly than the production anticipated, Van’t Hul stepped into the breach. “I suggested keeping digital effects in-house,” said Van’t Hul. “We gathered a small guerrilla team of in-house compositors to do composites to help bridge the gaps between small stages, extend environments, add skies and clouds. That helped keep the costs down, but it also helped Henry maintain creative interaction with shots as they were finalized.”



Costumers sewed wire armatures into fabric garments, allowing animators to create in-camera illusions of the cloth moving with natural weight and inertia. Costume fabricator Paloma Soledad accessorizes Coraline’s pajamas, which were custom dyed and silk-screened to replicate the fabric’s pattern in 42 copies of the tiny costume.

The in-house visual effects team occupied the upper floor of Laika's 183,000 square foot premises, allowing production and visual effects staff unique opportunities for interaction. "If compositors became frustrated working in a bunch of Dilbert-like offices," remarked Van't Hul, "they could go downstairs and be right there where the movie was being made. I'd take them to where the next scene they were going to composite was being shot. We'd talk through setups with the lighting cameraman, choose bluescreen or greenscreen backings, and, if we needed tracking markers, where they should be placed. Many times, compositors feel like they are the fall guy, and I often hear the question, 'Couldn't they have shot it this way or that?' This helped them understand that process."



Coraline converses with Wybie Lovat, a shy local boy with a fondness for BMX bicycle racing and slug collecting. Selick introduced Wybie to Gaiman's narrative to give voice to Coraline's internal monologues as she explores her new home and the strange parallel realms of the Other World. To create interactive fog that appears to rise and flow around the stop-motion characters, Brian Van't Hul's team shot live-action elements of dry ice, interacting with black velvet shapes. Compositors then digitally integrated the mist into scenes, warping and distorting elements and creating stereo effects.

A large part of the visual effects team's duties involved digital rig removal, painting out external puppet supports implemented by 10 personnel under head of puppet rigging David Lawson. "This film was more heavily rigged than any I have worked on," said Georgina Hayns. "We really went for it on the character designs: we had huge-breasted women with tiny ankles, we had Bobinsky with his huge belly and the longest, thinnest legs you could ever imagine. Ninety percent of our puppets needed to be rigged."

A smaller sub-group of artists handled cleanup of another omnipresent facet of the puppet animation — removing the seam lines that bisected the faces of facial replacement characters. "It was hotly contested whether the seam would be in or out," recalled Brian Van't Hul. "The hardcore stop-motion animators wanted to keep the crack to preserve the handcrafted feel. Eventually, we decided the seam would be distracting, because we had a lot of emotional closeups where we wanted to focus on what the characters were feeling."

Removing a seam bisecting the most prominent characters' faces in several hundred shots required a concerted effort handled by a separate effects department known as the 'Seam Team.' "We didn't have space where we were shooting," related Van't Hul, "so we set up a small facility in the Laika offices in downtown Portland, led by visual effects supervisor Steve Emerson. A couple of our best compositors worked through the R&D and created an elegant set of in-house tools using off-the-shelf technology. That enabled us to train artists in a short amount of time to create some pretty amazing results." To erase the facial seam and a joint around puppet necks, artists used rotoscoping to isolate areas, sampled textures from either side of seams to fill the gap, and added film grain. "We had to take into account the way the faces moved through pools of light, and then we had to blend them perfectly for left and right eye, otherwise the stereo would 'buzz.' Our CG supervisor, John Benson, made it work with one of our lead compositors, Tom Burney, and compositor Peter Vickery."

The production — featuring 130 sets, tended by 23 camera personnel, 35 animators, and 40 visual effects artists — required immense collective focus over the 84-week shoot. “One way to stay fresh,” revealed Pete Kozachik, “was to send messages to myself in the future. Every time I started a new sequence, I wrote notes for the scene and those notes went to all the camera guys and eventually other departments. If a sequence ran for six months on the stage — which was common — at least we had those notes that were written during a lucid moment.” The animation process was then kept in constant check with the momentum of shot production. “Henry understood that there was always a compromise between the need for a retake and the need to keep to a production timeline. I really appreciate that in him, because when you spend time on the studio floor, you realize how hard it can be for an animator to go through a reshoot. Often, if someone in the screening room pointed out a bit of minutia that they thought was worthy of a reshoot, Henry barked back, ‘We don’t care about that stuff!’ The imperfections were part of the charm.”

The movie begins with deliverymen from Ranft Brothers Moving Company unloading Coraline’s family belongings into the Pink Palace Apartments, a Victorian-style building in Oregon’s Blue Mountains. Establishing shots were achieved using digital matte paintings of pine forests and mountains layered behind the 1/6-scale exterior building façade constructed by set building supervisor Lee Bo Henry. Model shop supervisor Mitch Romanuski and team built the moving truck and hundreds of other props for the film making use of rapid prototype fabrication processes, as well as traditional model making techniques. Prop details included Henry Selick’s presidential likeness on a dollar bill that Coraline’s father offers up as a tip to the moving men. The taciturn, dungaree-wearing Ranft Bothers were sculpted in the likenesses of animation artists Jerome Ranft and his late brother Joseph.



Bobinsky reveals his athletic prowess and less-than-sanitary undergarments in an acrobatic display on his attic-level balcony. The lanky character, with pencil-thin legs and oversized belly, was one of the tallest and spindliest puppets created for the show, requiring extensive external puppet rigging on set and digital rig removal in postproduction.



Coraline’s other neighbors, Spink and Forcible, are an equally eccentric pair of upper-crust English actresses who live in a basement apartment with several Scottish terriers and a stash of ancient saltwater taffy.



Other Father and Other Mother offer to sew buttons into Coraline's eyes so that she may join them in their perfect Other World. Laika designed Coraline's Other parents to appear healthier and hipper than their dowdy real-world counterparts. Other Father sported dapper coiffure and rosy complexion, while Other Mother had perfect beauty makeup and no surgical neck-brace. Pete Kozachik used softer light and cooler tones in real-world settings, and then expanded the color palette and contrast values in the Other World to make the fantasy environment more appealing.



Key characters, including Other Mother, made use of two-part facial replacement animation pieces, which bisected puppet faces in a horizontal line above the bridge of the nose. Combinations of pieces allowed animators to create greater ranges of expressions with maximum efficiency. Laika's in-house visual effects department digitally erased the seams.

Coraline explores her new home, displaying gawky preteen mannerisms as she absently-mindedly moves from room to room, disturbing her parents at their computers. *Coraline*'s father was an entirely mechanical puppet, sporting different mechanical heads depending on the character's mood. "Father was a compromise," explained Henry Selick. "We built a 'positive series' mechanical head for him and a 'negative series' version; so he was already happy, or not, from the built-in sculpt."



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Coraline's many facial expressions were conveyed through more than 207,300 combinations of facial replacement pieces. "We felt *Coraline* should have a certain elegance and grace when she moved," said Travis Knight, "but she was also fond of stomping around in the mud. I can't speak to how other animators got their inspiration, but I drew my observations from my daughter. She's much younger than *Coraline*, but I made note of certain attitudes and motions and tried to put those into *Coraline*'s performance."

Shot creation involved an iterative production pipeline. "We'd begin by blocking out the scene," explained Knight. "We put the character through a few basic poses to make sure lighting, general choreography and the feeling of the shot were working. Henry then gave the animator a brief, describing the mood, feeling, story points, and if he wanted any specific poses. Then we'd do a rehearsal." Rehearsals were a dry run for performance, before committing to the time-consuming process of shooting on 'ones,' with a new puppet pose for every frame. "We shot rehearsals very quickly, either on twos or fours, to get basic choreography. We sometimes had multiple rehearsals before we'd shoot a take. Final animation nearly always combined ones and twos. A lot of facial animation was done on twos, especially with replacement pieces. As we developed the style of animation, we tried to embrace the handcrafted quality of stop-motion. We wanted to make performances sing, but there was only so much subtlety we could get out of pushing tiny little puppets around with our giant ham hands. Part of that understanding involved shooting some subtler movements on twos."

Animation of *Coraline*'s hair was achieved by teasing apart rigid strands frame by frame. "The hair was fairly tough to move," commented Knight. "It had to be, to hold its shape. I found the best way to move it was by using an X-Acto blade to pry little pieces of hair apart and shape them frame-by-frame. The X-Acto blade allowed me to get right down to hair-by-hair separations and push them around. Hopefully, when it was seen in motion, it felt soft and natural, rather than like something made out of glue and wire."



Animators articulated father puppets mechanically, using tiny paddles beneath the silicone skin to move brows, lips and jaw. Father heads were sculpted in 'positive' and 'negative' modes, for happy or sad scenes. Animator Jeff Riley positions Other Father for a musical number at a piano keyboard.

Coraline's discovery of the Other World occurs when she enters a hidden doorway in her living room wall, revealing a glowing purple and blue tunnel that appears to deepen with a Hitchcockian perspective shift. "The extending tunnel was a physical effect," said Kozachik. "It was about ten inches in diameter, six feet long, lit from outside by moving gobos. We rigged the tunnel vertically, with the back end attached to the studio floor, and compressed it down like a Slinky to about a fifth of its stretched-out length. We started with the tunnel fully squashed, the camera looking straight down it, and then as we moved the camera up in the air it pulled the front end of the tube with it."



In the Other World, Coraline discovers the dreary backyard of the Pink Palace apartments transformed into a magical garden, full of colorful, glowing and moving exotic plants tended by Other Father, who rides a praying-mantis-like mechanical riding lawnmower capable of flight. The Laika modelmaking team created an articulated puppet of the mantis-copter, designed as part of an insect motif that takes on a more sinister resonance when Coraline discovers the Other World to be a creation designed to lure her away from her real parents.

The use of 3D in the scene underlined the drama of the transition to the Other World. "Henry wanted to use 3D as a storytelling device," asserted Travis

Knight. "We very rarely had objects drift out into the audience. It was more about drawing people in. When *Coraline* entered the Other World through the portal, it was as if the tunnel was drawing her in. The first room she sees on the other side is a mirror of her normal living room, but it feels like there is more freedom, although the audience might not initially know why. We flattened out the construction of that set and used more exaggerated 3D to create a sense of depth and space."

Coraline discovers her button-eyed Other Mother preparing a roast chicken dinner, fawning over her daughter. "Trey Thomas, one of our animation leads, focused mainly on the Mother and the Other Mother," said Knight. "Trey is a big hulking mass of a man, but he had a real affinity for female movement. He did the most beautiful, elegant animation of female puppets." Knight animated Father and shared animation duties on Other Father with Jeff Reilly, who differentiated Other Father using vigorous poses as he serenaded Coraline at a mechanically-assisted player piano. "Other Dad was like Bing Crosby or Dean Martin, with skin painted in a warmer tone so he naturally exuded warmth. He had slightly different posture and his clothes were hipper."

The dinner table scene featured a model railway 'gravy train' that circled table decorations and festive candles. Visual effects added subtle details to the largely in-camera illusions. "The candles all had real candle flames," noted Brian Van't Hul. "We shot them with a RED digital camera and then tracked them and composited them in place. Laika's technical director Peter Stuart also created particle effects for puffs of smoke coming out of the train, generated in *Side Effects Houdini*."

Back in the real world, *Coraline* interacts with her neighbors — Mr. Bobinsky, a lanky Russian circus performer in the upper apartment (voiced by Ian McShane); Spink and Forcible (voiced by Jennifer Saunders and Dawn French), a pair of upper-crust English actresses who live in a basement apartment with three yapping Scottish terriers; and Wybie Lovat (voiced by Robert Bailey Jr.), a character not featured in Neil Gaiman’s book. “*Coraline* had a lot of internal monologue in the book,” said Travis Knight. “Instead of dramatizing that as a voiceover, Henry wanted to give *Coraline* another kid to talk with; so he invented Wybie, this quirky, shy local boy who is intrigued by *Coraline*.” Knight animated the character using facial replacements. “We spent a long time working out his mannerisms and posture. He was hyper-shy and deflected that by talking quickly. To emphasize his shyness, we made him turn his head to the side, hunch his back and bring his elbows and hands into his body, as if he was protecting himself. He was a weird, quirky little creature, but hopefully endearing.”

Wybie’s companion is a stray cat that later, in the Other Mother’s realm, develops the ability to speak (voiced by Keith David). The cat was sculpted at two scales — one for wider shots and another for more detailed closeup work — then was cast in foam latex and dressed with scraggly fur. “Parts of the cat were flocked,” said Georgina Hayns, “and parts had clumps of fur sticking out, because he was supposed to look quite scrawny.” The cat had a replacement animation muzzle, swiveling ears, and large mechanically animated eyes. “The eyes were set into little sockets on the head core. Henry wanted them to be reflective, like a real cat’s, so we laid Scotchlite on the inside of each eye and then painted those blue.”

As *Coraline* chats with Wybie, fog rolls in, first trickling across the ground and then filling the garden waist deep. Visual effects provided tendrils of mist and ground fog as live-action elements. “One of our lead compositors, Aiden Frasier, and I shot dry ice that we later composited into the stop-motion shots,” explained Brian Van’t Hul. “We shot a lot of generic elements, and, for more interactive angles, we set up 400-percent-size foam blocks covered with black velvet and shot mist rolling down slopes and wrapping around objects. We also shot a lot of smaller trickles and wisps as helper elements that could be combined to make it look like the fog was interacting with Wybie and *Coraline*. We shot most of those elements with the RED camera at about 100 frames per second. It was not a deep stereo sequence, so we shot those ‘mono,’ and then warped and distorted mist into stereo effects.”

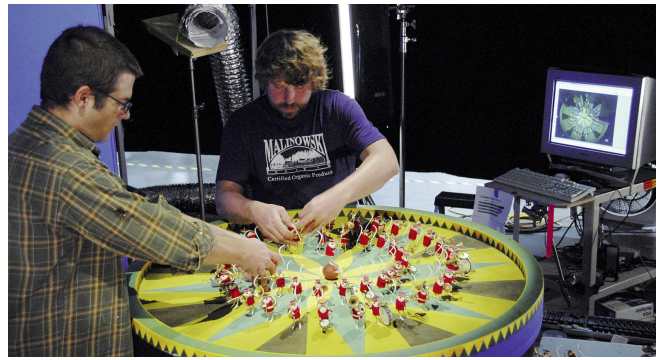


Animator Kent Burton animates the Other Father on the mantis-copter, which he rides about the garden on wheels and insect legs before the machine sprouts helicopter blades. Laika photographed airborne copter scenes of Other Father taking Coraline for a joyride over the garden by shooting the mantis-copter and riders as greenscreen elements and then shooting a smaller-scale enchanted garden for down-views. The in-house visual effects team composited the mantis-copter as foreground elements against the garden set and added set extensions beyond the garden using digital matte paintings of mountains, trees and starry night skies.

When *Coraline* returns to the Other World, she discovers her Other Father tending a garden of fantastic, colorful glowing plants. Greeting her entry to the garden are golden hummingbirds, created as replacement animation puppets that were filmed against greenscreen and composited into the scene. Other Father then invites *Coraline* on board a riding mower resembling an oversized praying mantis, which sprouts helicopter blades and flies above a flower bed in the shape of *Coraline*'s smiling face. The mantis-copter was animated against greenscreen and then composited against smaller-scale shrubbery lit with ultraviolet light.

Coraline teams up with Other Wybie — a mute, button-eyed version of her new friend — and visits Other Bobinsky in the upstairs apartment, which now contains a chicken-powered popcorn machine, cotton-candy-firing cannons and a small, illuminated circus tent. The tent miraculously houses a circus ring of 50 jumping mice that enact a spectacular Busby Berkeley dance routine, animated with approximately 600 replacement-animation pieces. "We had 50 mice playing five or six different kinds of instruments," related Henry Selick. "It would have been hellacious to animate all of those mechanically, performing very repetitive jumping and marching motions. So we animated those as complete body replacements in animation cycles that we could use over and over. We did have an early discussion about whether it would have been more appropriate to animate the mice as CG characters, but I felt that the minute any character went CG, it would have lost its charm and lessened the impact of the scene."

Mice were replicated in silicone with interchangeable legs, bodies and heads, some with separate hats. The rapid prototype team output mice at 100-percent puppet-scale for direct interactions with *Coraline* and ringmaster Other World Bobinsky, and at 220-percent scale — measuring just over two inches tall — to enable more dexterous manipulations of the tiny creatures. Brian Van't Hul



Coraline encounters a circus troupe of dancing mice in the Other World version of Bobinsky's attic apartment. Laika previsualized the sequence to choreograph a Busby-Berkeley-style dance routine. Brian Van't Hul's camera team aligned the animatic to an overhead view of the circus ring to help guide stop-motion animation captured in-camera using replacement animation mice. Animators Bartek Prusiewicz and Kevin Glick attend the horde of tiny puppet mice.



Animator Theresa Drilling oversees an Other World auditorium filled with yapping Scottie dogs where *Coraline* and Other Wybie take seats for a spectacular theater production.



Miss Forcible, in Other World guise, reveals hidden talents in a show-stopping burlesque act reminiscent of

then led photography of the sequence, combining scales. To combine larger mice and outer rings of smaller puppets, motion control programmer and matchmove artist Nic Marrison created scaled repeat camera moves. “Nic and I had worked at Weta Digital for the last eight years,” said Van’t Hul, “and we were used to pushing matchmove data back and forth between miniatures and live-action. He flew out from New Zealand and was very helpful in making elements knit together.”

Every mouse in the mouse circus was filmed in-camera, without digital replication, manipulated on set by two animators who used previsualization to guide complex choreography. “We had a couple of video frame-grabbers on set,” Van’t Hul explained. “One gave us a feed from the camera; another gave us a view from a camera that we mounted above the set looking straight down on the mice as they marched around in formation. We overlaid previz reference frames onto the video assist from our top-down camera. The animators could then line up animation of the mice to the previz.”

Coraline and Other Wybie next venture into the basement to find it transformed into a giant theater full of Scottie dogs viewing a burlesque show starring Spink and Forcible in risqué stage attire. The puppet fabrication team created 450 silicone dog puppets that could be animated by a single animator. “We mechanized the dogs in rows,” explained Georgina Hayns. “Henry wanted 90 percent of their movement to be from their necks, barking and reacting to the show. We wired some puppets to have jaw movement that the animator could hand-animate for closeups, but most of them were rigged like a big automaton on a rotating cam connected to a motion control rig that slowly moved them frame by frame.”

Lead animator Eric Leighton animated the dramatic entry of Forcible, who rises like Venus on a clamshell clad in a metallic bikini. “I called Eric ‘Mr. Sex and Violence,’” remarked Henry Selick. “He’d been working in digital animation recently, but he wanted to get his hands on real puppets again, so he came out to Portland for almost the whole schedule and he did brilliant work.”

Partway through the stage show, Spink and Forcible unzip their elderly skins and emerge as their leggy younger selves to take flight with a trapeze and high-dive act. The fabrication department created special unzipping rigs for the transformations, animated by Anthony Elworthy. “We made a hollow skin,” said Georgina Hayns. “We cast silicone into the molds, backed it with a mesh of wire and left an opening in the front of the wire. Anthony then cut into the silicone and revealed different stages of Young Forcible — first her arms and head, and then her body, fed in through a

Botticelli’s ‘Birth of Venus.’ The puppet fabrication team created Forcible’s flowing golden mane as a tiny wig of synthetic hair woven with fine metallic thread bound with a gooey mix of hair products. Animation lead Eric Leighton, a veteran of Henry Selick’s earlier productions, brought the stage show to life.



The Other World dissolves around Coraline and her feline companion as they try to escape through an orchard. Henry Selick took inspiration for the look of the Other World deconstruction from graphic designer Tadahiro Uesugi. During preproduction, Uesugi produced conceptual paintings of characters and environments rendered with a delicate color palette and a retro beatnik vibe. Laika then used a multimedia approach to create effects of the world disintegrating around Coraline by shooting puppets in a white-out plexiglas environment, combined with clay- and scratch- animation, computer graphics and particle effects rendered with a Uesugi sensibility.

hole in the off-camera side of the puppet, while he slowly drew the skin down and made it crush around her feet. And then he used the whole puppet for when she jumped out of her skin.”

Despite the allure of the Other World, *Coraline* is annoyed to find the portal back to her own world locked, and tries to escape through an orchard, which dissolves into limbo. To create an arbor full of cherry trees in bloom, the model-makers dressed 40 miniature trees with popcorn kernels painted to resemble blossoms. Laika then animated *Coraline* and the cat on a sheet of translucent plexiglas backed by whitewashed walls, and created a digital transition to the limbo realm. “*Coraline* is on an endless walk as she tries to run away,” Henry Selick explained. “Things get pale, the trees transform, their branches become very angular, their leaves become square, and everything gets lighter until it disappears; and then *Coraline* gets to the other side of this wilderness, and she’s back where she started. That became a motif for the way the world disappeared later in the movie. We applied it to various elements — the moon and sky, the distant horizon, mountains and trees — creating beautiful and abstract designs very much inspired by Tadahiro Uesugi’s artwork.”



In the Other World Pink Palace, Coraline is briefly incarcerated in a darkened chamber with the ghosts of three children previously enslaved by the Other Mother. To create translucent glowing ghost effects, Laika shot the ghost puppets separately, using motion control to record repeat passes first with stop-motion ghost puppets and then with light bulbs placed in frame to create the ghosts’ interactive glows. The Laika visual effects team then layered elements to align floating apparitions in stereoscopic space with Coraline and her environment.

Coraline arrives back at the house where Other Mother reveals her true form as the gaunt and bony Beldam, animated with operatic flair by Trey Thomas. “The transformation was replacement and mechanical,” said Georgina Hayns. “The Other Mother went from a round-faced, pretty woman to a rather gaunt supermodel. The facial ‘morph’ — as we called it — was done with replacements. We then had an over-the-shoulder shot where the Beldam’s dress stretched out. We built rigs inside her dress to stretch the fabric from a short collar to a larger collar. We started with the puppet hunching her back and then stretching up. For the next stage, she started leaning forward, and unraveled until she was standing upright.”

The Beldam tosses *Coraline* through a mirror, which magically expels her into a small dark room. Animator Misha Klein created the transition through the mirror by replacing it with a greenscreen backing behind the frame for the moments when puppets penetrated the glass. Cameraman Peter Williams then shot repeat passes with a mirror in place, and visual effects rotoscoped character intersections with the mirror surface.

Inside the darkened room, *Coraline* encounters glowing ghosts of three small children imprisoned by the Beldam. “We shot the ghosts mostly in the same set as *Coraline*,” stated Pete Kozachik, “but we never shot them at the same time. We reverted to a greenscreen environment whenever we added the ghosts, and we animated them to float on motion control rigging. After we had shot the ghosts, we replaced them with light bulbs. We shielded the glare from camera with Blackwrap, and the light from the lamps illuminated *Coraline* and her environment as if the ghosts were casting their glow.”

Tom Burney combined ghost elements to ensure correct alignments of light passes, puppets, and backgrounds, layered with corresponding depth cues in stereo space.

When Other Wybie pulls *Coraline* from the mirror she learns that the Other World is starting to decay. Other Father degenerates by reverting to a lopsided half-man/half-vegetable monster that is absorbed into his garden. “Other Father’s face starts stretching and becomes sweaty and horrible,” said Georgina Hayns. “We did that using Smooth-On Dragon Skin, which is a special platinum core silicone rubber that stretches but doesn’t tear. Anthony Elworthy animated that with an armature that contained a wound-up spring inside Father’s face, which had a concertina effect that stretched the jaw down.”

Spink and Forcible, too, transform into a disturbing apparition, the two characters becoming intertwined inside a giant wrapper resembling their favorite confection: saltwater taffy. “We made the ‘Taffy Monster’ out of silicone,” noted Hayns. “It was a mechanical armature puppet that Anthony Elworthy animated. Henry wanted the arms to stretch extremely far, so we built six versions that could be swapped on and off. There was no replacement animation, and no CG, but we came up with some pretty nasty head armatures so that the puppet could screech and scream at camera.”

As the Beldam loses control of the Other World, the environment outside the Pink Palace drains of color and disintegrates in a mixture of animation techniques. “The moon begins to disintegrate,” said Brian Van’t Hul, “and then the sky peels away in a series of lines and squares and geometric shapes based on Tadahiro Uesugi’s art. To create the patterns, we built a large down-shooter above a piece of glass that was under-lit, covered in black paint and scratch animated. Peter Stuart then generated particles in Houdini based on those patterns, creating flakes falling out of the sky and flying through the air.” As the sky erodes to the horizon, mountains fly apart and hurtle towards *Coraline*. Claymation specialist Richard Zimmerman created the animated mountain range as a large two-dimensional clay frieze, studded with inch-high miniature trees, and covering a backlit white plexiglas table. Zimmerman chipped away at the clay, frame by frame, in angular Uesugi patterns. Visual effects then combined elements with digital particles rendered as sprites that chase *Coraline* into the house.

Coraline stumbles into a living room, now populated by scuttling furniture, where the Beldam approaches, transformed into a six-legged monster. “Phil Dale animated the final iteration of the Other Mother,” recalled Travis Knight. “She was a horrific praying-mantis-spider-type creature on spindly little legs. The puppet had to be constantly supported on external rigs, with a gossamer dress on an internal wire armature that had to be futzed with every frame. Phil had the seemingly insurmountable task of making this mass of metal and silicone appear menacing, but also exude



Coraline faces off with the Other Mother, who has now reverted to her true form as the hideous Beldam – a gaunt, spider- limbed creature. The puppet fabrication team built the Beldam puppet as a two-and-a-half-foot- tall structure of spider-thin metal armatures, skinned in silicone and clothed in black-and-white- checked, silver-netted fabric with internal wire rigging. Puppet makers created fine detail of the Beldam’s exposed metal claws using jewelry casting processes to create metal finger bones out of solid silver. Joints were then drilled and pinned with very small hinges, and tensioned using superglue and sticky wax.

sexiness and warmth. Even in her scariest moments, Henry wanted Other Mother to be alluring as she is trying to entice *Coraline* to stay.”

The living room then comes apart, floorboards collapsing to reveal a giant spider web onto which characters cling. Shattering floorboards and the giant funnel web were in-camera stop-motion effects assisted by digital rod removal. “We built a large spiral web that dropped down through the set,” said Pete Kozachik. “The web was made out of steel, and a great deal of rigging was involved. We animated the very springy web by turning cranks to make cables pull on individual parts of it. Several animators worked on it in concert, giving it a considerable amount of life and what appeared to be real physics.”

Coraline scrambles through the portal and slams shut the door on the Beldam’s hand, severing it at the wrist. The metal claw then pursues her to a finale in the real-world garden. Laika built the tiny severed Beldam claw at 100-percent puppet size, and larger versions at 150 percent and 300 percent for closeup work. The intricate exposed animation armatures, with articulated joints not much thicker than a spider limb, were cast out of silver to preserve fine detail. “We sculpted and cast each part using the lost wax process,” said Georgina Hayns. “A jewelry company molded the master sculpt and cast wax pieces. They made a mold around the wax, melted out the wax and injected silver in through sprue-holes. That avoided making any seam lines, so each part came out pretty much perfect.”

Shots of the Beldam hand scampering through the garden, chasing after *Coraline*, often required the smallest and most delicate puppet claw. “Beldam hands had rigging points on the wrists because they couldn’t support their own weight,” said Travis Knight. “They were not easy to animate, and they could very easily bend or break. We only used the 300-percent version in one or two closeup shots because the larger puppet would have required building up the surrounding set to the same scale, and that just wasn’t feasible. For most of the shots it was either the 100- or the 150-percent.” Knight animated the Beldam hand to convey a range of emotions through its poses. “It moved somewhat like a crab, but it had a creepy humor as it crawled around, jumping and leaping. Our composer, Bruno Coulais, did a wonderful job in the score, playing up the hand’s mischievous quality.”

Coraline and Wybie dispatch the hand with the help of an abandoned well, after which neighbors and family reunite for a garden party, bringing the film to a close in an epic crane shot. “The last scene of the movie turned out to be one of our most complicated shots,” recalled Pete Kozachik. “The cameraman, Mark Stewart, set it up in five different stages. The camera snaked its way through the garden behind the house as *Coraline* stopped to chat with groups of people, and then it rose up to look back at the garden, tracked over the house and landed in the front yard.” The shot involved multiple interlocking motion control setups, which visual effects tracked and composited together. “We shot the garden in three setups, with another setup for deep background garden elements, and then we shot some of the characters on greenscreen, matchmoved to be in registration to the set. The house was another element, shot at the same scale, about six feet tall. We used a different rig to shoot the surrounding landscape, with smaller-scale background foliage, and then Brian and his guys tied it all together with a digital matte painting backing. It was a monumental shot.”

The mantra of using tactile media to bring to life the world of *Coraline's Other World* ultimately brought the filmmakers full circle back to an underlying theme of Neil Gaiman's book. "The common thread was that we, like the Other Mother, hand-made this world for *Coraline*," stated Henry Selick. "That was why I felt stop-motion would be the best medium for this story, because nothing captured that handmade feeling better than stop-motion. We used a lot of new tools to help us, but in the end it came down to hundreds of people making everything by hand. It was very important for me to hold onto that, to be true to the essence of the characters and the sensibility of Neil's book."

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The Manhattan Project

image

Article by Joe Fordham

One of the most influential comic books in the superhero canon appeared in 1986 when DC Comics published *Watchmen*, by Alan Moore and Dave Gibbons. The 12-part series, later reissued as a single graphic novel, told the story of a group of masked vigilantes, descended from crime-fighters of the 1940s. Struggling with their identity in the twilight of their careers, these superheroes are riddled with self-doubt, political agendas, existential crises and impotency problems, even as an unknown assailant is killing off the last of their kind.

Watchmen received critical acclaim, and prospects for a feature film adaptation soon followed; but the complex narrative eluded adaptation by high-profile screenwriters and directors, including Terry Gilliam, David Hayter, Darren Aronofsky and Paul Greengrass. Producers Lawrence Gordon and Lloyd Levin eventually brought the project to Warner Bros. and filmmaker Zack Snyder, who at the time was preparing a film based on Frank Miller's graphic novel, *300*.

As a long-time admirer of Moore's and Gibbon's book, Snyder was intrigued at the prospect of exploring *Watchmen*; and after four months' work, he had filled six sketchbooks with 3,000 drawings inspired by the graphic novel and the screenplay by David Hayter and Alex Tse. "I had done the same thing on *300*," Snyder recalled, "but with *Watchmen* it was a much more intellectual exercise. The book was a modern, adult piece of literature that contemplated our place in the universe."

A central figure in the story, and one of the main challenges the filmmakers faced, was the depiction of Jonathan Osterman, a scientist inadvertently exposed to lethal radiation who transforms into an omniscient, glowing blue superbeing known as Dr. Manhattan. Tests for the character had been developed at Framestore, for an earlier aborted production based in England, using a muscular performer painted with ultraviolet pigments. Snyder opted to begin with a clean slate, generating the character in a manner that more closely resembled the depictions in the graphic novel.

Visual effects supervisor John 'DJ' DesJardin interviewed with Snyder to discuss concepts for the project and found that he shared similar ideas about creating the enigmatic central character. "Zack described what he wanted Doc to do," DesJardin recalled. "At one point he had to be 45 feet tall; another time we had to see him 100 feet tall; yet another time he had to separate into four beings — and we didn't want to shoot motion control for any of that. Zack also wanted the glow that emanated from Doc to light up the environments he was in." Deciding to make Dr. Manhattan an all-CG character, Snyder and DesJardin took inspiration from Sony Pictures Imageworks' CG human work on *Beowulf*, as well as from Industrial Light & Magic's work on the *Pirates of the Caribbean* sequels, which had featured photorealistic CG characters based on a real-time on-set performance. "I thought, 'What if we could bring that technology to set, with a very portable witness camera operation?'" I knew Zack liked to shoot really fast, 30 setups a day, so we'd keep it performance-

friendly. The idea was to dress an actor in a suit with some kind of tracking capability, and fit that suit with thousands of LEDs to make him a light source.”

Imageworks first developed a small-scale film test at New Deal Studios. Chris Gilman, president and founder of Global Effects, manufacturers of custom suit creations, fashioned a shoulder-length glove covered in bright blue LEDs as a proof-of-concept prototype. John DesJardin later did a test using a full-body version of the suit, with visual effects producer Tricia Mulgrew standing in as Manhattan’s love interest. Using a preliminary shader to depict Manhattan’s incandescent glow, Imageworks visual effects supervisor Pete Travers created a sequence from the test footage. “Sony had a blocking of the CG character in three days,” recalled DesJardin. “They borrowed their *Beowulf* model, because that was their best-rigged human body at the time. We walked in this blue-shaded character, he talked to Trish, they hugged — giving us some nice closeup interaction with the light — and then he sat down on the couch.” DesJardin presented the test to Snyder, who was by now in preproduction in Vancouver. “When I showed it to Zack, I half-expected him to say, ‘Okay, that’s pretty good, but what do we do from there?’ But Zack and his producers said: ‘Oh, my God, that’s really cool! We know how to do this now.’ We were off and running.”

Production designer Alex McDowell selected Vancouver as a production base to accommodate the construction of a large backlot set designed to represent the graphic novel’s alternative New York City, circa 1985. McDowell previsualized set designs with Proof in Los Angeles and then with Frantic Films in Vancouver. Visual effects then developed animatics for specific action sequences and digital set extensions. “Alex laid out the streets as per the graphic novel,” observed John DesJardin, “and I focused on up and down views of the streets. I was mainly concerned with getting enough greenscreen material to cover the width of a street, and enough height so that when we shot characters close up we would not frame off the tops of screens, which would have required more rotoscoping.” DesJardin divided set extension work between Imageworks and The Moving Picture Company’s new Canadian extension of its London studio.

MPC launched operations in Vancouver with a number of its experienced London artists steering the project. “We had a mix of Canadians and people from other countries,” said MPC visual effects supervisor Jessica Norman. “Our core team from London, including CG supervisor Max Wood and 2D supervisor Matthew Adams, helped get us going and made sure we maintained the quality of work. We had a modeling and texture lead, two R&D people, one focusing on effects, a lighting lead, and compositors who were familiar with our tools, which helped to make the transition easier. We ended up handling 24 sequences, and all but four of those we did in Canada.”

New York City set extensions involved digital matte paintings and 2D texture projections onto geometry drawn from 1980s period reference and photographic surveys of present-day New York and Seattle. MPC also built a library of airships to dress the skies. “We populated a lot of our shots with blimps,” said Norman. “We rendered turntables of all our blimps that we could composite into shots, but many were full 3D to give us appropriate motion.”



The Comedian (Jeffrey Dean Morgan), Silk Spectre (Malin Ackerman), Dr. Manhattan (Billy Crudup), Ozymandias (Matthew Goode), Nite Owl (Stephen McHattie) and Rorschach (Jackie Earle Haley) take a photo-call in director

Derived from a detail in the graphic novel, one of the most distinctive blimps was designed as an airborne advertisement for an Indian fast-food restaurant, the 'Gunga Diner.' "The Gunga Diner blimp was in the shape of a pink elephant, and was featured in quite a few of our shots, including one of our bigger New York pullbacks where we started inside a room and pulled all the way back across half of Manhattan. The camera went right past this huge pink elephant. It had animated neon signs, propellers, lights in its eyes and some nice closeup texture work. It helped give the city a slightly different feel."

This unusual, period New York City is home to the Watchmen. Costume designer Michael Wilkinson commissioned Quantum Creation FX to build superhero suits for the Watchmen team. The most complex suit design was for Nite Owl (Patrick Wilson) — morally conflicted scientist and inventor Dan Dreiberg — who wore a cowl and cape in a hooded bird design. Quantum sculptor Jose Fernandez, working from Wilkinson's designs, modeled and painted a three-dimensional maquette, and then generated a full body suit, cowl, goggles and capes. "Michael wanted to keep costumes very faithful to the comic," commented Christian Beckman, who co-supervised operations at Quantum Creation with Justin Raleigh. "We had to bring them into this new world, but make them look slick. Nite Owl was a traditional foam suit, which Moto Hata sculpted over a lifecast of the actor. We molded that, cast hard pieces in resin and body-shopped and polished them for several days to get a smooth metal look. Then we remolded it and sprayed it with a dark bronze finish using rubber ink paints."

After multiple fittings with the actors and stunt performers, Michael Wilkinson, assistant designer Christine Bieselin and Quantum created hero suits and unpainted practice suits for rehearsals. Both Nite Owl and Ozymandias (Matthew Goode) — brilliant but egotistical industrialist Adrian Veidt — wore sculpted body suits with capes. Quantum created capes by combining latex and fabric, cast flat and bonded together, with sculpted detail areas to create depth.

Zack Snyder's adaptation of *Watchmen*. Based on Alan Moore's and Dave Gibbons' graphic novel rumination on superhero lore, the project pooled talents from many disciplines — special effects, visual effects, miniatures, makeup effects and custom suit fabrication. Joel Whist, who choreographed *Damien* and *100*, supervised special effects, while visual effects supervisor John "Dr. Desjardin" Overaw supervised digital effects shots produced at Sony Pictures Imageworks, The Moving Picture Company, Intelligent Creatures and CIS Hollywood. Jeffrey Dean Morgan took his death fall on a wire harness, which propelled the actor through an empty window frame backed by greenscreen. MPC digitally generated the exterior cityscape, rebuilt the penthouse set and retimed the stunt to transition to a digital double interacting with dynamic slow-motion breaking glass effects.



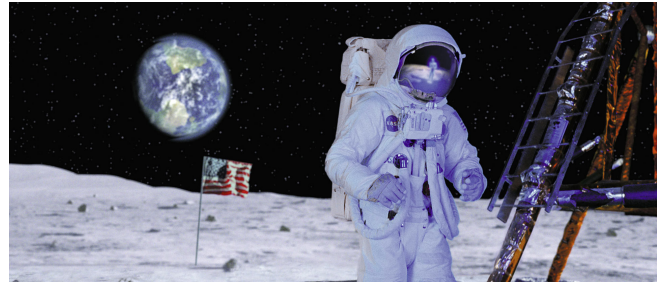
In a title sequence tracing the history of the Watchmen, the filmmakers crafted a montage of scenes that dipped in and out of slow motion, simulating varispeed effects by having performers hold their positions in frame while the motion picture camera moved around them. CIS Hollywood then augmented scenes with digital effects. For a re-creation of the famous Life magazine photo, 'V-J Day in Times Square,' Zack Snyder filmed actors in a greenscreen environment, with streamers and confetti. CIS modeled Times Square from historical photo reference, and added digital background crowd and atmospheric effects.

Ozymandias and the Comedian (Jeffrey Dean Morgan) — gruff, animalistic freedom fighter Edward Blake — both wore eye-masks, sculpted to fit lifecasts of the performers, then cast in urethane. The makeup department detailed the masks with paint makeup around the eyes. The Comedian's costume, resembling military body armor, included a sculpted upper-body muscle suit with prosthetic arms that extended from the performer's wrists and a chest and neckpiece that blended to his neck.

Quantum also fabricated costume pieces for Rorschach (Jackie Earle Haley) — psychotic vigilante Walter Kovacs — who wore a head-encasing fabric hood patterned with moving inkblots. “Alan Moore explained why Rorschach's mask moves in the *Absolute Watchmen* book,” said Zack Snyder. “It was a fabric that Dr. Manhattan had created. It had an oily substance between two advanced pieces of fabric, and those oils were constantly moving. In the film, it's still possible that Manhattan created the fabric — we never say — but I wanted the fabric to appear to work on a more molecular level. The black ink oozed through the fabric, constantly moving through the fibers like blood soaking in gauze.”

For scenes of Rorschach's mask in static mode, Quantum created 13 fabric hoods, three with inkblot designs based on patterns supplied by Michael Wilkinson's team. Hoods fitted over a foam latex understructure sculpted to the performer's head that Jackie Earle Haley wore to create a streamlined silhouette. For the majority of Rorschach's scenes, Haley performed wearing an uninked hood, dotted with tracking markers, with an opening for his face. “We wanted to see Jackie's eyes so we could figure out what he was thinking,” noted John DesJardin. “The inkblots had to reflect that, to a degree. Dave Gibbons drew them that way in the graphic novel. Our goal was to get the patterns to look like they weren't just floating on the surface of the mask.”

The production initiated Rorschach tests with Frantic Films. Intelligent Creatures then developed the look, motion and production pipeline in a four-month research and development process for more than 300 visual effects shots. Rorschach's mask animation involved a multi-layered combination of 2D and 3D processes, with inkblot designs based on the graphic novel. Intelligent Creatures developed a vocabulary of inkblots from the art department's selection of key poses, and timed the ebb and flow of the abstract shapes in concert with Haley's mercurial performance. “Designs expressed anger, chaos or calm,” observed Intelligent Creatures visual effects supervisor Lon Molnar. “We analyzed the action to see if those shapes should snap back quickly or flow, reflecting Rorschach's mood. We drew those in Maya, working on a tablet the way a classical animator would work with pencil on paper, pose-to-pose, then hit ‘play’ and generated in-betweens. When we wanted to control an in-between, we could stop, draw that pose and press ‘play’ again. Then we rendered that animation as hard-edged shapes.”



Dr. Manhattan greets an astronaut on the surface of the moon during an Apollo landing. Production designer Alex McDowell built a small portion of the moon's surface and a partial lunar excursion module on a soundstage in Vancouver. CIS Hollywood then extended the LEM, and created a 3D model of the moon terrain, sky and earth. Imageworks supplied an animated model of Dr. Manhattan to CIS, which placed the luminous blue character on its 3D moon model and mapped that image onto the astronaut's visor.

Intelligent Creatures 3D supervisor Jeff Newton, meanwhile, oversaw the development of an animation model of Rorschach's head. John DesJardin supplied lighting reference from the set and cyberscans of Haley with and without his mask. Intelligent Creatures tracked the model to markers on the performer's head. "We employed rigid geometry tracking techniques to matchmove movements of Jackie's skull," explained Newton. "We tracked the deforming parts of his face using a hybrid of matchmove and animation. The green dots on the moving parts of the mask gave us two-dimensional information of the performance. We projected that onto geometry of the non-deforming head. That gave us a 2½D animation that had all the nuances of the actor's movements locked to the movement of the skull. That technique worked for most medium-to-wide shots. For close shots, however, our match animators finessed the motion by hand."

2D supervisor Greg Astles oversaw blending of inkblots to the digital head, from Rorschach's coat collar up to the base of the character's fedora hat, by layering multiple passes. "We rendered lighter layers under the darker inkblot shape," stated Lon Molnar. "That created volume, depth and density, so it felt like the ink was moving through cloth." To blend inkblots to the mask, Intelligent Creatures experimented with emitting 2D particles from animated inkblot curves, but eventually settled on a procedural noise effect, which made ink appear to bleed into the distressed fabric. "The mask contained very fine fibers that looked worn, as if Rorschach had washed it many times. The fibers really showed up in rim-lit shots, so we added a little bit of a fur shader to our CG mask. That helped tie it in with the natural lighting."

Makeup effects by Drac Studios helped to realize the superhero characters, and also created an array of supporting characters, historical likenesses and prosthetic gore effects. Co-founders Todd Tucker and Harvey Lowry, in partnership with Oscar-winning makeup artist Greg Cannom, generated prosthetics that included 26 likenesses of politicians, artists and celebrities spanning the movie's 40-year timeline. Logistical demands required many makeups to be created within a very short turnaround. "When I first began the project," stated Cannom, "I arrived in Vancouver, and the production told me: 'Nixon and Kennedy shoot next week. Can you do it?' I said, 'I'll try!' We had about ten days to create those makeups."



Rorschach, a psychotic vigilante obsessed with finding who is behind a plot to kill off the Watchmen, investigates the circumstances surrounding the Comedian's death. Jackie Earle Haley played Rorschach's scenes wearing a head-encasing fabric hood, dotted with green tracking markers, with an opening for his face. Intelligent Creatures then modeled Haley's head from cyberscans of the actor with and without the hood, and generated animation to represent moving inkblots that appeared to swim through the mask in response to changes in Rorschach's emotional state. Mapping and tracking inkblots to the hood involved a multi-layered combination of 2D and 3D processes.

Drac Studios sculptor Miles Teves shared sculpting duties with Cannom, while silicone supervisor Marc Nieman worked 18-hour days to ensure rapid turnaround of prosthetic pieces. “We did our moldmaking and silicone as efficiently as possibly,” said Cannom. “Luckily the style for this film allowed makeups to be a little bit stylized. They weren’t over-the-top cartoony, but the historical figures had to be instantly recognizable.” Teves and Cannom sculpted three ages of Nixon, which Cannom and makeup artist Will Huff applied on set. “We did a younger Nixon from the 1970s, and then ‘80s and ‘90s versions. As he got older, his hair grayed and his nose got bigger.” Drac’s likeness makeup of John F. Kennedy (Brett Stimely) included a full prosthetic neck, chin, cheeks and nose. Other makeups included Fidel Castro and Henry Kissinger, created in collaboration with makeup department head Rosalina Da Silva, who handled celebrity look-alike actors cast to resemble public figures including Andy Warhol and John Lennon.

The time-hopping narrative also necessitated age makeups for lead performers, including the Comedian and his one-time love interest, matriarchal superhero Sally Jupiter (Carla Gugino) seen in her 1940s beauty queen heyday and then as the aged mother to her glamorous daughter, Silk Spectre (Malin Ackerman). “Carla was fantastic,” observed Cannom. “We aged her with silicone prosthetics to her sixties. She showed off her knees, so I wrinkled the hell out of those, too. Zack didn’t want her to look as aged as in the graphic novel, so we kept her very attractive.”

In the opening of the film, the middle-aged Comedian, scarred and heavysset, is brutally murdered by an intruder in his penthouse apartment. The filmmakers shot the scene with Jeffrey Dean Morgan in prosthetic makeup on a soundstage set in Vancouver. Stunt coordinator and fight choreographer Damon Caro, veteran of 300, worked closely on fight design with special effects supervisor Joel Whist. “When the intruder kicks the door open,” observed Whist, “it wasn’t a simple gag with a weakened balsa door section. Zack wanted the whole lock to come out as a chunk. The door was very detailed dark mahogany, and the camera was very close up, so we couldn’t hide any weakening. It had to be strong enough to look solid, and yet break easily enough for the stunt.” Whist’s effects team created the breakaway effect, after extensive testing, using a section of cedar wood packed with broken wood chunks, laminated with mahogany on the camera side, weakened invisibly with the grain.

The intruder pummels the Comedian into submission by hurling him across the room into a wall and a heavy smoked glass table. The stunt and effects departments rigged a ratchet cable gag to haul the Comedian the full length of the room. Whist’s team created a breakaway glass table as a custom half-inch-thick pour of translucent colored resin on a weakened frame. Technicians replaced metal table legs with a milled balsa center beam, pre-cut, painted black and then glued back together to snap like metal. The stunt team then rigged the Comedian with an upper and lower cable — the



Dr. Manhattan – the former Dr. Jonathan Osterman – at work in a military research center where he manipulates his surroundings using telekinesis and other mysterious powers. Early in preproduction, the filmmakers determined that the most effective way to depict Dr. Manhattan would be to create a CG character based on performance capture of an actor outfitted with lights to

upper cable suspending the performer and the lower cable pulling him down on-to the table.

cast interactive glows on set. Tests conducted at Imageworks, where artists mapped a 3D model onto footage of a performer in a prototype light suit, proved the concept.

MPC added city views outside the greenscreen window and digitally enhanced a closeup of the

intruder's fist impacting the Comedian's face, warping his face and adding tendrils of flying drool.

The intruder then slams the Comedian face-first into a countertop, shattering the surface. Whist's team collaborated with the art department to create a replaceable section of the counter, cast in colored wax mixed with tempera powder to produce a granite look. Technicians pre-scored the 1.5-inch-thick slab of wax, which cracked as the stunt performer made impact with his shoulder.

The intruder then tosses the Comedian to his death through the plate-glass window. Snyder shot Jeffrey Dean Morgan on wires taking the fall in slow motion through an unglazed window backed by greenscreen. MPC finessed the move and completed the environment in postproduction. "Jeffrey reacted to the impact a little early," said Jessica Norman, "so we ended up replacing the whole room and blending to a digital double earlier than we had planned to get the right interaction and lighting. We created the city outside with a mix of 3D buildings, 2D projection and digital matte painting on cards. Everything outside the window was digital — the street, the cars, the people, and all the falling glass."

As the Comedian falls, his signature yellow 'smiley' pin spins into foreground and is splashed with a drop of blood, generated at MPC as a tiny fluid simulation. "MPC modeled a CG pin to match the practical prop," noted John DesJardin. "Property master Jimmy Chow made a bunch of pins with different blood drops. Zack approved one that matched the classic pin that Dave Gibbons drew in the book. That became the one we mimicked throughout the movie."

For the title sequence that follows, yU+co tracked motion graphics of opening credits through a montage of scenes that trace the history of the Watchmen. “I wanted to show how the 20th century had been impacted by these masked vigilantes,” Zack Snyder related. “I sketched sequences that I thought would be cool, without trying to intellectualize it too much, acknowledging the influence of popular culture.” Snyder utilized speed ramping transitions to decelerate action to super-slow-motion tableaux, accomplished by having actors hold position as the camera moved around them. “A lot of the film related intellectually to the concept of suspended time and nostalgia for times gone by. The title sequence was about expressing media through history, revealing the camera taking a photo. Slow-motion allowed the audience to absorb the flash moment.”

CIS created digital enhancements in title scenes, adding atmospheric details suspended in midair, seen as a 1930s superhero wrestles a gun from a gangster, frozen in the glare of a newspaperman’s flashbulb. “We created the flashbulb light in-camera,” noted John DesJardin. “On set, our team flashed a lamp really fast, shot 50 frames per second. With the actors moving very slowly, it looked like it was 200 or 300 frames per second. CIS then added a little ripple, CG shell casings in the air and volumetric smoke.”

The sequence included a twist on the Life magazine photograph, ‘V-J Day in Times Square,’ with a female sailor and nurse in a passionate embrace at the end of World War II. Snyder shot performers in a minimal set backed by greenscreen, and CIS extended the environment. “We used a copy of the old photo and a bunch of reference taken that same day around Times Square,” CIS visual effects supervisor Bryan Hirota elaborated. “It was framed 95-percent greenscreen, apart from a few vehicles in back and a 5-percent sliver of a building in the first 30 frames of the shot.” CIS London built and textured a model of the environment, which CIS Hollywood then completed. “We added period billboards and advertisements, and an artificial-intelligence Massive CG crowd to extend the real crowd in shot. They had some confetti and streamers dropping, but we extended those with particle animation and added CG birds flying in the sky.”



Global Effects created a light suit for Billy Crudup to wear on set. The suit contained a network of some 2,500 light-emitting diodes, with custom circuitry that boosted brightness levels to ensure the lights would read on camera, even in brightly illuminated scenes. Lights were stitched onto removable velcro strips that facilitated modular removal and replacement. Light strips on Crudup’s arms, fingers and the soles of his feet created interactive glows on sets, props and other performers as the actor moved through scenes. Imageworks supplied two-inch-square bar code markers that assisted tracking through 3D space using video-based image processing.

The opening title sequence also features John F. Kennedy's assassination in a tracking shot that moves past an onlooker with an 8mm camera and then reveals the Comedian with a smoking rifle on a nearby grassy knoll. The production dressed a strip of road in a parking lot in Vancouver and painted the surrounding area green. In the foreground, the construction team built a 20-foot-tall platform on which grassy-knoll performers took position. DesJardin shot the scene with sunlight striking the road from an angle as the president's car went by, corresponding to archival footage. CIS matchmoved the shot, generated Dealey Plaza from historical reference photographs and added a CG overpass, CG grass and digital period cars in a parking lot. The Kennedy performer tilted back his head, simulating bullet impacts, and CIS added fluid dynamic simulations of RealFlow blood with particle effects and rigid body dynamic chunks of gore.



In flashback, Osterman recalls the laboratory accident that transformed him into a glowing superbeing by scrambling his atomic structure in an intrinsic field generator. Zack Snyder filmed the initial disintegration scene by flooding the generator set with bright strobe lights, while special effects blasted Crudup with air movers. Imageworks then developed a dynamic simulation for the disintegration, layering cloth simulations of Osterman's clothing and lab coat over a 3D model of musculature, internal organs and skeleton.

The montage also introduces Dr. Manhattan (Billy Crudup) reflected in the visor of an Apollo astronaut on the surface of the moon — another minimal set that CIS enhanced with a digital moonscape and lunar module. The sequence ends with a terrorist explosion that blows out the window of an electrical appliance store. CIS digitally enhanced the practical effect with pyrotechnic elements and debris.

Rorschach investigates the Comedian's death with his fellow Watchmen and arrives at Rockefeller Military Research Center where Dr. Manhattan is standing, 45 feet tall, repairing a nuclear reactor. "We used a big blue balloon-light high up in the set to throw Doc's light around the lab," said John DesJardin. "Billy Crudup was off to the side, wearing a light suit, and we captured his performance; so as Doc shrank to human size we ended up with Billy in the spot he needed to be, walking forward into his first closeup."

Imageworks captured Crudup's performance on set using a pair of high-definition witness cameras phase-synced to the motion picture film camera to triangulate Manhattan's position in 3D space. "We used two witness cameras wherever possible," DesJardin observed. "We often had one camera angled on its side to get Billy's full head-to-toe image, while the other was focused on tracking markers on his face. The film camera was our most important performance capture reference, because that's what told the story."

Crudup performed all Dr. Manhattan scenes wearing a Global Effects light suit covered with a network of approximately 2,500 blue LEDs rigged with custom circuitry that boosted brightness levels to two settings — intense and super-bright. Lights were stitched onto removable velcro strips that allowed modular removal and replacements. A battery and a circuit box were similarly attached. Imageworks fitted Crudup with a plastic skullcap with rows of LEDs that plugged into the circuitry. Crudup wore gloves with light strips on his palms and fingers, and illuminated shoes with LEDs in clear urethane soles that created interactive glows beneath Manhattan's feet.

A disparity between the actor's five-foot-seven height and Manhattan's six-foot-two stature was initially solved by elevating the actor on apple boxes to approximate correct eye-lines. The apple boxes were later replaced with platform shoes. "While we were shooting in Vancouver," related Chris Gilman, "I happened to stop by a dancewear store and saw these platform dance shoes that looked like what Gene Simmons had worn in the rock band Kiss. I brought them back to set; and when Billy put them on, he loved them! We made a new pattern for the shoes, cast a toe-piece and heel, and then attached our LEDs into the upper arches so the shoes made a complete glowing footprint."

Global Effects made four light suits for Crudup and his doubles, equipped with two-inch-square bar code markers that assisted tracking bodies through 3D space. "Each marker was unique," said Pete Travers. "We used pattern recognition software that could identify each bar code pattern and locate it relative to its position on Billy's body. It was video-based image processing, not motion capture." Imageworks lead software engineer Parag Havaldar oversaw image-processing tools, which became part of the arsenal of tracking tools employed to lock Crudup's on-screen performance to the 3D character. "Tracking always breaks down when an object is moving too fast, or if there's not enough detail; and so our image recognition system was useful, but we couldn't rely on it alone. Sometimes it was pretty tricky just finding places to put our witness cameras. The first setup we had with Doc was in a tiny living room — it was probably the tiniest set that we had in the whole five-month



Dr. Manhattan partially reintegrates on the grounds of the research center, appearing as a network of tentacles that resembles a human nervous system. Billy Crudup performed the scene in his light suit. Imageworks then integrated a 3D character using fluid simulations.



Manhattan's ability to divide himself into multiples and reintegrate at will is displayed in a laboratory scene, in which three Mannhattans coalesce into one. Zack Snyder choreographed light-suit doubles to step into frame and align their bodies until Crudup's outline obscured them from camera. Imageworks then animated interactive glows.

shoot — so we could only use one camera. In hindsight, that was a good experience to put our system to the test.”

The production took lidar surveys of the sets in which Manhattan appeared and, after shooting Crudup’s light-suit performance, shot a second-pass clean plate to capture backgrounds to assist layering the CG character. “There were always places where our CG character did not completely overlap the actor,” Travers observed. “Typical digital paint solutions did not apply because our character was emitting blue light and every time he moved, the background lighting changed.”

To simulate Manhattan’s interactive lighting in clean plates, the filmmakers placed a light stick in frame to cast a blue glow across the scene. “The light stick was Billy’s height and had the same LEDs all over it,” said John DesJardin. “We put that in and repeated the camera move, walking the light through the same focal movements — a poor man’s motion control. That gave us clean plates with a stronger light source than Billy’s suit emitted, which Imageworks used to paint back areas of the plate.” Imageworks matchmove lead Amiee Campbell oversaw plate reconstruction, sharing painstaking matchmove and paint duties with Imageworks India.

Imageworks compositors then layered in the digital Dr. Manhattan, modeled as a statuesque nude with a facial likeness of Crudup derived from cyberscans and facial acquisition of the performer enunciating a library of phonemes. Digital effects supervisor David Seager led development of Manhattan’s irradiated look. “We didn’t want Doc’s face to be too translucent,” remarked Pete Travers. “We used subsurface lighting and a lot of other tricks to make his skin glow, but we didn’t overplay those effects because we wanted to be able to read his expressions. Billy gave such a subtle performance — sometimes he’d just give a glance towards Malin and then a trace of a smile — if we had overplayed the effects we’d have missed those moments.”

Animation supervisor Kenn McDonald oversaw application of keyframe controls that allowed animators to interpret witness camera data. Motion capture supervisor Joshua Ochoa calibrated data on set using range-of-motion tests with Crudup to establish alignments of light-suit LEDs and facial dots. “There was inevitably a little bit of slippage in marker positions every day,” said Travers, “so at the beginning and end of every shoot, Billy repeated motions with his facial expressions and body. We then processed that data, plugged it onto the animation rig, and it acted as a base coat that the animator could either strip out or use to activate facial tracking. It was helpful when we were figuring out the timing of when Billy hit certain sounds in his speech.”

Manhattan’s eyes were entirely keyframe-animated, with minute saccades suggesting flickers of thought. “The pupils were the brightest points,” said Travers, “and we could dilate them. There was a subtle falloff to the sclera, and a corneal bulge that showed through the eyelids. The eyes were a



President Richard M. Nixon (Robert Wisden) enlists Dr. Manhattan as an instrument of U.S. foreign policy. Drac Studios created prosthetics for the film, including 26 likenesses of politicians, artists and celebrities spanning the narrative’s 40-year timeline. Drac sculptor Miles Teves shared sculpting duties with makeup effects supervisor Greg Cannom to create three ages of Nixon for flashbacks to the 1970s, and for scenes in the film’s alternative history timeline that depicted the president in power decades beyond his historical incumbency.

source of illumination in Doc's face; so when he blinked, the light they cast on the bridge of his nose blinked out."

The filmmakers chose not to be coy with Manhattan's nudity, which was a story point that suggested the character's apathetic disregard of human vanity. "Viewing dailies was a human resources disaster," Travers recalled. "The word 'penis' was used at least twenty times each session. We had to do a wedge of penis sizes, director approved, and the famous 'frame 22' was the frame he picked. But the crew was very professional about it — we knew early on that the film was going to be rated 'R' — and after a while we just accepted it. Billy's performance was so good, Doc's nudity became secondary to the story."

Textural effects included a layer of peach fuzz on Manhattan's skin, with eyelashes and eyebrow hairs that became visible in three-quarter backlight. While experimenting with lighting, digital effects

supervisor Daniel Kramer suggested an atmospheric detail that became a signature for the character, using Hou-dini particles to create motes of dust illuminated in

Manhattan's radiance — known as 'ridleys.' "Ridley Scott uses a lot of those kinds of atmospheric effects in his films," observed Zack Snyder, "so we named them after him. We animated ridleys to be brighter when they were close to Doc, but fainter when they got further away. They really helped peg him into his environment."

Out of the just under 400 shots produced at Imageworks, Dr. Manhattan appeared in 320 shots, occupying approximately 38 minutes of screen time. Scenes included the character displaying an ability to casually divide himself into multiples for multi-tasking. Snyder filmed a laboratory scene of three Mannhattans coalescing into one by choreographing light-suit doubles to step into frame behind Crudup, one by one ducking out of view as Crudup's outline obscured them from camera. In a more complex scene, Manhattan divides while making love with Silk Spectre. "We shot that with four Mannhattans in light suits," noted John DesJardin. "Billy was always the featured one, and then we had another double in bed with him and Malin, so four light-suit arms were touching her. We shot a clean plate with just Malin and the light stick." Imageworks CG supervisor Max Bruce oversaw the integration of digital Mannhattans, which involved some of the film's most demanding digital paint fixes.



Another flashback depicts Dr. Manhattan – grown to 100 feet tall – during his military service in Vietnam. Zack Snyder filmed Vietnam scenes on a Vancouver soundstage set backed by bluescreen. Billy Crudup provided elevated eye-lines for ground-level performers by taking position on a scaffold upstage. Imageworks animated Manhattan striding through the scene and Svengali Visual Effects generated digital matte paintings for the backgrounds. Final composites incorporated miniature elements, shot at New Deal Studios, of burning tropical foliage and steel palm trees set ablaze with propane.

Manhattan uses telekinesis, moving objects with the power of his mind, to reconstruct the Rockefeller laboratory nuclear reactor and, in a later sequence, to dress himself in a suit and tie. Imageworks animated 3D floating objects hovering in midair; and in the dressing scene animated clothing to Crudup's mimed actions. "Billy moved his arms as if he was putting on a vest," said Pete Travers. "We generated the vest slipping on and the shirt buttoning. The simulation involved both an inverse and forward simulation, so the buttons buttoned themselves and the shirt responded to that." Imageworks rendered Manhattan's radiance through the fabric of the shirt, which glowed with less intensity through thicker fabric of seams and cuffs.

For scenes of Manhattan in civilian clothes, Crudup wore portions of the light suit on his upper body and head. "That was another reason we designed the suit in components," observed Chris Gilman. "We knew there were going to be scenes where Billy didn't need to be in the entire suit. The biggest trick when he was wearing civilian clothes was where to place the electronics and battery, because the suit was super-snug. We ended up hanging the battery and electronics outside the suit on the off-camera side. And then, as he turned, we velcroed the packs where they were less obtrusive."

Harassed by negative public opinion, Manhattan teleports to Mars. Snyder filmed the red planet scenes on a 20-foot-square studio set that was surrounded on three sides by greenscreen. Imageworks generated environment extensions based on stylized interpretations of NASA reference. "In most modern images of Mars," commented Pete Travers, "the sky is a uniform pale red color. Zack liked photographs we found that had a much more polarized sky, darker than the mountains below, so we used strong gradated filters to create that effect. Our CG supervisor, Max Bruce, oversaw that sequence, balancing realism with strong, stark lighting."

Alone on Mars, Manhattan reminisces about the laboratory accident that scrambled his atomic structure in an intrinsic field generator. Crudup performed the disintegration scene in a laboratory set illuminated by bright strobe lights, while Joel Whist's team blasted the actor with air movers. DesJardin shot a clean plate of the scene, and then Imageworks lead effects animator David Stephens devised a simulation to tear Manhattan's flesh and bones apart. "It was an extremely complicated half-soft, half-rigid body solution," said Travers. "We built Billy with his shirt, pants and lab coat as separate pieces, all the way down to his skeleton and internal organs. We then applied a dynamic simulation so, as pieces tore away, they interacted with one another and then disintegrated."



For a scene in which Silk Spectre joins Nite Owl to rescue victims trapped inside a burning tenement building, the production used full-scale set pieces shot in Vancouver and miniature elements filmed at New Deal Studios. The miniature shoot employed a 1/3-scale tenement rooftop, which New Deal built using flame-retardant materials and plumbed with a network of gas jets rigged to emit flames. For the end of the sequence, New Deal rigged a water tank to collapse and douse the flames. MPC integrated the miniature elements with digital environment extensions.

Manhattan attempts to reintegrate his body and, at first, startles scientists by appearing as a network of tentacles resembling a nervous system. “We made use of technology that we had developed for Venom in *Spider-Man 3*,” explained Travers. “Billy Crudup performed those scenes on set in his light suit so we would get the light interactions on the environment. We painted him out, blocked in the character to match his performance and then, when we added the tentacles, applied a fluid simulation on top to create a flowing, jellyfish look.”

Effects animation supervisor Carl Hooper generated a partially-fleshed apparition for a scene in which Manhattan flickers into existence in the research center, pounding the walls in agony. “Zack asked us to make that scene like the transformation scenes in *Altered States*,” said John DesJardin. “We used all the components and glows that went into making up Manhattan and added little starry ethereal particles around him. Zack called them ‘V’gers’ because they reminded him of the effects from the end of *Star Trek: The Motion Picture*.”

To film Manhattan’s completed manifestation, hovering nude in the research facility cafeteria, Crudup stood in his light suit on a small platform of apple boxes, while Joel Whist’s team used air cannons, a wind machine and a radial light rig to flare above the set. Imageworks inserted Manhattan, match-animated to Crudup, into a clean plate, with added drift to create the sense of levitation. Effects animators generated levitating silverware and debris caught in the zero-gravity field, with atmospheric effects and rays of light.

The filmmakers designed Manhattan’s teleportations and destructive moments with physical interactions created by using a device known as the ‘boosh 2000.’ “We called it the boosh 2000,” explained Joel Whist, “because during production meetings Zack would say, ‘Okay, Dr. Manhattan disappears and then, boosh!’ He always used ‘boosh’ to describe the event. He wanted to create a radial air blast from the core of Manhattan, which started as a light source and then — boosh — air radiated out and affected his environment.” Effects technicians built the boosh rig as a freestanding pipe, capped by a light, connected to air cannons that sent out a circular blade of wind approximately 30 feet. “We also aimed air cannons like shotguns at specific objects or people on set to really move them.”

Manhattan’s destructive powers are first seen in a nightclub scene in which Doc hurls balls of energy at mobsters. Physical effects interactions required split-second timing to register correctly on film. “We mounted flash packs to the performers’ sternums,” said Whist. “We timed those to go off with computer control, which we tested and timed to a tenth of a second. Timing depended on how far the air cannon was from the performer: at a certain distance, we’d have to release the air 10



Nite Owl's flying vehicle, the Owl Ship, departs its subterranean hideout through flooded New York City subway tunnels and then emerges from the Hudson River. MPC generated the surfacing scene as an entirely digital re-creation of a frame in the graphic novel, with a CG city, ship and water simulations. Modelers created the digital Owl Ship from scans and photographic surveys of a full-scale prop built in Vancouver. MPC combined a simulated column of water, which exploded from the river as the Owl Ship breached the surface, with more detailed spray simulations.

thousandths of a second after the light blast. At other times we'd do the air blast first. That was crucial for DJ to tie into with his visual effects."

Imageworks generated Manhattan's energy as a roiling, organic flow of light that stemmed from his internal structure. "Zack wanted Doc to appear to be made of the cosmos," explained Pete Travers. "We tried to subtly represent that in his destruction effects with an internal fluid simulation in the same vein as his teleportation effect. Before he blew up the mobsters, the fluid energy built up in his body, moving from his chest to his hands. Zack didn't want a ray beam shooting from Doc's hands. It was more of a subtle gesture, which made the mutilation more shocking." The physical effects team created grisly impacts using an off-camera blood cannon to spray bystanders with gore, followed by a mobster skeleton dressed with chunks of shattered body parts rigged to the ceiling of the set. Effects technicians blasted the skeleton with 15 gallons of fake blood and guts and simultaneously released pressure pots above the ceiling, causing more gore to drip down, while a limb fell away and the jaw unhinged.

Manhattan, grown to 100 feet tall, wreaks further havoc on the battlefields of Vietnam, accompanying the Comedian in a flashback to their glory days in combat. Snyder filmed performers on a 60-by-40-foot soundstage set backed by bluescreen. Crudup took position on a scaffold to provide elevated eye-lines for ground level performers. Imageworks then animated Manhattan to stride through the scene at titanic scale, while Svengali Visual Effects generated digital matte paintings of backgrounds. "I had an animatic to show where they wanted the land masses and sun," related Svengali supervisor Rocco Gioffre. "They wanted it to be very similar to *Apocalypse Now*, with a big sunrise in the background and helicopters coming toward camera. I created sky, clouds and all the jungle surroundings using photo reference." New Deal Studios supplied pyrotechnic elements by filming burning tropical foliage dressed into a miniature wire mesh hillside, backed by bluescreen, and built steel palm trees plumbed with propane flames. Gioffre combined the elements with greenscreen footage of the Comedian wielding a practical flamethrower, and then Imageworks added synthetic smoke plumes, aircraft and Manhattan obliterating Viet Cong.

Meditating on his memories, Dr. Manhattan raises a giant palace of rotating crystal mechanisms out of the Martian soil. Alex McDowell adapted the crystal palace design as a radial arrangement of gears, previsualized at Frantic Films and then generated at Imageworks. "We decided Manhattan's mind was so expanded that he was not bound to normal clockwork physics," observed John DesJardin. "We had Frantic Films do some tests of scaled rotations allowing interpenetration of surfaces, and then we examined how surfaces hit each other. Since the mechanical pieces were segmented, we decided we could animate them using avoidance: if two pieces were colliding, we simply had them move out of each other's way. That produced some neat interactions where mechanisms would flutter as if struggling to avoid collision."

To grow the palace from Martian soil, the production first shot film tests in Vancouver with Joel Whist's team, which dropped pieces of glass and wood into a four-foot-square box containing 400 pounds of cocoa powder. Imageworks then referenced the tests to generate soil interactions using full 3D simulations, as crystal palace spires broke the ground, shattering a brittle crust, and then emerged with softer soil clumping and streaming off its surfaces. Max Bruce used Pixar's RenderMan to render Martian terrain, and a customized version of Messiah Studio's Arnold to

render crystals with ray-traced refractions, reflections and internal V'ger effects. "I don't think anybody has rendered a structure with this many refraction properties before," remarked Pete Travers. "As the palace came out of the ground, the environment behind it had to refract through it, and then that glass had to reflect the foreground glass through all the smoke and debris. We did that by precompositing the background, and then utilizing those layers to refract through the structure."

For scenes of Manhattan in the palace, and later scenes of his teleporting Silk Spectre to Mars, Snyder filmed Crudup in a light suit interacting with Malin Ackerman on a partial greenscreen set. Imageworks completed the environment and animated the giant structure taking flight with Manhattan and Silk Spectre on board, traversing Martian vistas, including a flyby of Olympus Mons, created using 2D and 3D projection techniques.

After the crystal palace comes to rest, and Manhattan and Silk Spectre disembark, Imageworks brought the giant structure crashing down utilizing complex rigid body dynamic simulations. "Dave Stephens developed a full 3D simulation to completely shatter the crystal palace," related Travers. "The tricky part was that we couldn't make the fractures visible before the pieces came apart — it would have looked like a cracked glass palace stuck together. We had to reveal the cracks as they shattered."

The Mars sequence concludes with a pullback from Manhattan and Silk Spectre, ending in a high-altitude reveal of Gale Crater — a natural geological feature resembling a smiley face on Mars, first photographed by NASA's Viking orbiter in 1976. Svengali Visual Effects digital matte painter Michele Moen painted elements for the shot, which Max Bruce and technical director Jeff Dillinger integrated, working with Rocco Gioffre. "We nested a series of paintings that fit into one another," said Gioffre. "We started with the closest painting and fitted that into a portion of a wider painting, and kept painting wider. Michele did the tighter angles and widest views. When it came time to figure out the in-between paintings, I worked with Imageworks as a house call."

While Manhattan debates his return to earth, other Watchmen struggle to keep the peace. Public malcontent is illustrated in an earlier flashback



As a global groundswell of anti-superhero sentiment builds against the Watchmen, Dr. Manhattan takes leave of the human race and teleports to the isolation of the planet Mars, where he contemplates his past and his place in the universe. For scenes of Manhattan on Mars, the production built a 20-by-20-foot slab of Martian terrain on a soundstage in Vancouver, flanked on three sides with greenscreen. Billy Crudup then enacted scenes in the Manhattan light suit, producing interactive glows on the Martian soil.



Imageworks studied NASA photographic reference to develop digital environment extensions for red planet scenes. Zack Snyder selected an atypical image of a polarized Martian sky, which Imageworks used as a touchstone to light the scene. In wide shots of Manhattan standing alone, Imageworks replaced the studio set with a fully CG terrain to create a dramatic contrast of the digital

when Nite Owl and the Comedian use a two-man flying vehicle, the Owl Ship, to disperse a riot in New York City streets. Snyder filmed the scene on the Vancouver backlot set, with a full-scale, 9,000-pound Owl Ship prop furnished by the art, construction and special effects departments. “The Owl Ship was constructed like an eggshell with a floor frame that we tied into when we hung it above the set,” stated Joel Whist. “There were two cables at the front of the ship, going through the roof down into the floor, and one at the back. We hung it from a puppeteering frame supported by a 300-ton crane. The frame had computer-controlled electric winches that were operated with joystick control. It had three axes of motion, so we could make it hover, pitching and yawing and slowly going up and down to give it life.”

MPC scanned and photographed the full-scale prop and create a 3D model for dynamic shots of the Owl Ship in flight. “The Owl Ship was one of our hero characters,” said Jessica Norman. “We ended up being really close to it and following it through several environments, for night and daytime scenes, so we spent a lot of time on the modeling. It had details inside and out, and digi-doubles of characters that were flying it.” MPC used its in-house artificial crowd simulation, Alice, to fill out the New York City riot, and layered in 3D city extensions.

Scenes of the Owl Ship at rest in Nite Owl’s basement ‘owl chamber’ featured Nite Owl and Silk Spectre interacting with the practical prop. “We used the practical Owl Ship as it started taking off from its cradle,” said Joel Whist. “It was sitting underneath a gantry crane to effect repairs. We dressed the winches that we used to fly the Owl Ship on the backlot into the gantry crane; and then, as the ship started to lift off, we hooked our cables to it and used those to raise and lower it as if it was getting ready to go.”

For Owl Ship launch scenes, MPC integrated the CG vehicle into digital set extensions. “It was difficult to get the camera high enough in the ceiling of the owl chamber set,” said Jessica Norman. “So to do a camera move when the ship performed a 180-degree rotation and set down on its cradle, we used lidar data of the set and projected photographic textures onto geometry. That allowed us to create a CG camera move with the CG ship as it threw up dust and smoke from its thrusters.” MPC generated synthetic environments to depict the Owl Ship launching through a disused subway station. “The Owl Ship plunges into a flooded tunnel, and we follow it through the water, with blue moonlight beaming through. We generated water in Maya with some custom tools and used live-action splashes from our library of water effects.”

character’s ethereal glow against the darkened planet surface. An enormous crystalline structure rises from the Martian surface and then sails across the landscape, piloted by its creator, Dr. Manhattan. Imageworks generated the crystal palace from renderings by the production art department and previsualizations developed at Frantic Films. The palace design adapted the graphic novel’s original depictions into spherical arrangements of intersecting clockwork mechanisms. Interactions with the Martian terrain were based on film tests of solid objects falling into powdered cocoa. Imageworks rendered crystal palace geometries with ray-traced refractions, reflections and internal sparkling effects, interacting with 3D simulations of spires shattering the planet surface.



Ozymandias retreats to Karnak, his high-tech research center in Antarctica. MPC created digital Antarctic environments based upon production previz and photographic reference of polar landscapes, and created exterior views of the Karnak facility based on Alex McDowell’s designs. For the center’s main structure, MPC projected digital matte paintings and incorporated a 3D glass pyramid.

In a fully CG shot generated at MPC — which closely emulated a panel in the comic — the Owl Ship emerges from the Hudson River, its upward motion drawing a column of water beneath it. “We had to re-create that effect, but at the same time make it realistic,” Norman observed. “Zack and DJ wanted it to be a little bit more explosive than the ‘bubblegum’ look of the water in the book. We first focused on the motion of the main water column, and then used that simulation to drive more detailed simulations of water flowing down. We then integrated that mass of water into the water surface and simulated spray and mist on top, with very few live-action water elements.”

The partnership between Silk Spectre and Night Owl leads to a romantic tryst and an abstract dream sequence in which the characters make love and rip away their skins in the glare of an atomic explosion. The production shot the sequence on a cracked-earth set backed by greenscreen, with interactive lighting simulating nuclear backlight. The wardrobe department made greenscreen hoods for Malin Ackerman and Patrick Wilson to wear over their superhero outfits. The actors performed nude and then clothed, tearing open Velcro seams in the greenscreen material. MPC used cyberscans of the performers to create 3D models and projected nude textures onto a cloth simulation to peel back skin, revealing superheroes beneath. Effects animators generated the nuclear detonation using Maya fluids rendered in Mental Ray, and employed dynamic simulations to shatter superhero bodies.

Silk Spectre and Nite Owl rescue occupants of a tenement fire using the Owl Ship, hovering adjacent to the burning building. For airborne Owl Ship interiors, special effects rigged the full-scale prop on a computer-controlled motion base filmed against greenscreen. MPC handled Owl Ship animation and set extensions for tenement fire exteriors, incorporating live-action closeups on a partial studio set, and a miniature rooftop built and filmed by New Deal Studios.

Miniature effects supervisor Ian Hunter oversaw production of the scene in the New Deal parking lot, where concert-rigging specialists ShowRig erected a large truss-mounted 360-degree black backdrop. Miniature construction crew chief Forest Fischer then oversaw the assembly of a 1/3-scale tenement roof and wall on an elevated platform. Fischer’s team built substructures out of lumber double-sheathed with a drywall fire barrier. Modelmakers laminated walls with sheets of brickwork cast in hydrocal, then fitted the roof with sheet metal and used a plasma cutter to create holes for propane jets. Pyrotechnician Kelly Kirby plumbed the miniature with fire effects controlled from a crow’s nest high above the set. “Our flame effects had to be specific to the production’s previz,” commented Ian Hunter. “The camera had to pass in front of the building, so the back of the set needed to have



Using a sub-quantum intrinsic field generator, Ozymandias harnesses Dr. Manhattan’s energy and discharges emanations of cosmic energy to devastate cities around the world. A searing ball of energy materializes midair and scythes through a large portion of New York City. For street-level views, the production shot foreground characters on the Vancouver backlot, with stuntmen on wires simulating impact from the energy blast. Imageworks then generated radiating energy effects, CG vehicles and debris. Higher angles and aerial views of Times Square featured entirely synthetic environments incorporating 3D buildings blown apart by complex rigid dynamic simulations.

very tall flames. Other shots were at the back of the building, and the camera had to pass over the roof through the fire — so flames had to be very controllable.”

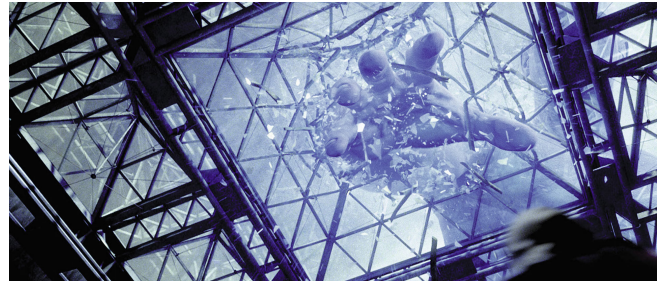
Four pyrotechnicians choreographed a network of 30 gas jets that issued flames through the set. Steel fireboxes burned propane foreground fires in tenement windows. Larger fireboxes emitted flames from the building’s far side, simulating flames from unseen windows. To feed flames through the roof, Kirby’s team placed fireboxes beneath openings in the sheet metal and fitted propane jets and secondary streams of polypropylene gas, which burned orange, creating a variety of incendiary effects. For more detailed burns, modelmakers also fitted one-inch-tall steel fireboxes into channels in the roof to feed flames to openings covered with steel mesh and roof paper.

To extinguish the inferno, Nite Owl shoots out the legs of a rooftop water tower. New Deal Studios mechanical effects supervisor Scott Beverly rigged the collapsing tower on the 1/3-scale miniature. Engineers built the water tank as a steel frame, lined with bender board that was waterproofed with sprayable urethane. The tank stood on dummy wooden staves, plywood at the back and balsa at the front, and it was hinged to fall using pneumatic pistons and a pneumatic ratchet that pushed and pulled the tank.

Director of miniature photography Tim Angulo covered the tank collapse with a Technocrane move that swung the camera toward the tank, and two additional cameras to capture a closeup and a higher angle. Once fires were lit, Angulo ran cameras at 48 frames per second. Ian Hunter detonated squibs to blow out balsa staves and hit a microswitch, toppling the tank and dumping thousands of gallons of water across the set. MPC added digital city backgrounds, extended the tenement to street level, enhanced glows and rendered additional black smoke, which assisted integration of the CG Owl Ship.

For shots of Silk Spectre entering the burning tenement, Zack Snyder filmed Malin Ackerman and her stunt double amid full-scale pyrotechnic effects. “We had 56 propane flame bars going at one point,” said Joel Whist. “When Silk Spectre first drops through the burning ceiling with all the debris, that was a stunt person. But for a tighter shot, we dropped residual debris around Malin, with all the fires, steam and dripping water.” For a subsequent angle as an explosion detonates in the corridor and Silk Spectre avoids the blast, Ackerman performed in front of a greenscreen, which CIS composited as a varispeed effect, with additional 3D debris kicked up by the explosion.

Rorschach and Nite Owl later employ the Owl Ship to fly to Antarctica, where they suspect Ozymandias is orchestrating the plot against the Watchmen. John DesJardin and Frantic Films previsualized the Owl Ship skimming ice floes and narrowly avoiding collision with an ice cliff. DesJardin then supplied the previz and photographic reference of polar landscapes to MPC, which generated arctic environments using digital matte painting and texture projections.



Dr. Manhattan, grown to giant size, teleports to Karnak and attacks Ozymandias’ control room. For side views of Manhattan’s arm reaching into the room, Joel Whist’s physical effects team created breakaway effects. A large blue balloon light suspended above the set cast interactive glows. For up-angles of Manhattan’s hand reaching through the ceiling, Imageworks re-created the control room ceiling using tiled background plates, then employed dynamic simulations to create breaking glass and steel interacting with the digital character.

Nite Owl loses control of the Owl Ship and crash-lands in the snow. MPC built the environment as a projected matte painting and created snow interactions based on full-scale reference. “We found some very useful video reference of trains plowing through deep snow,” explained Jessica Norman. “The trains had big wedge-shaped scoops in front that created huge sprays of snow. We re-created that look using a lot of effects elements to create interaction between the Owl Ship and the snow. The elements varied from large chunks of ice to medium- sized snowballs to finer sprite-based spray.”

The Watchmen make their way on foot to Ozymandias’ high-tech research facility, Karnak. Alex McDowell created interior sets of Karnak’s main control room, entry tunnel, main stairway and hall with greenscreens in window areas. MPC created exteriors based on McDowell’s designs. “The main building and its mandibles in front were projected digital matte paintings with additional lighting,” stated Norman. “We lit and rendered a glass pyramid on top of the building, and did some minor set extensions inside, topping up walls, adding ceilings and getting the right kind of light coming through from the sky.”

From within the massive Karnak control room, Ozymandias monitors mounting global discord on a giant wall of video monitors displaying news reports from around the world. CIS handled burn-ins of the monitor array, mostly using stock news footage from the 1980s, and added title graphics to news reports of global unrest.

A large, regal mutant lynx named Bubastis prowls at Ozymandias’ side as he greets his guests. Imageworks generated the exotic cat as an entirely digital creation. “We had two different cut-out stand-ins of Bubastis,” said John DesJardin. “We placed those in set to show the actors where she would be. We shot plates with the stand-in; and then sometimes to get the motion and timing right, Zack walked a chrome ball and gray ball through the scene for lighting reference. We had some pretty complicated lighting setups in Karnak, with lights coming from the floor and the ceiling, so it was important to have a good record of all that information.”

For close interactions of Ozymandias running his fingers through Bubastis’ coat, the production used a greenscreen-colored pelt of fake fur. Imageworks CG supervisor Darren Lurie then oversaw creation of a fully furred, digitally animated creature based on nature reference. “We started with a lion model and modified it from there,” explained Pete Travers. “A lion was the most akin to Bubastis, but we made the ears a lot longer.”

David Stephens created a complex dynamic simulation of Bubastis — with interactive internal organs, flesh, fur and skeleton — for the animal’s death in the blast of an intrinsic field generator, which Ozymandias has transported to Karnak as part of his master plan. Imageworks created generator energy using fluid simulations and lightning effects resembling earlier emanations of Manhattan’s energy. “We introduced the same lightning effects as in the love scene with Silk Spectre,” said Travers. “We had little sparks come out from Doc’s fingers as he is rubbing his hand along her body. We also used them in teleporting scenes. The reactor utilized Doc’s energy, so it had that same kind of look.”

The exploitation of Manhattan’s energy replaced a plot device in the graphic novel in which Ozymandias summoned a giant squid-like creature from the fifth dimension to terrorize New York.

“The idea of replacing the squid was in the script when I got it,” commented Zack Snyder. “I talked to David Hayter about where the idea came from and he said that when he had been working with Darren Aronofsky, Darren put him in touch with a physicist who had mentioned this as a potential concept. The squid was difficult to render, it added a lot more story that we had to tell, and it seemed more elegant to have Ozymandias use Manhattan’s energy instead of introducing this new element. We briefly batted around the idea of putting the squid back in, but when we started to talk about what we’d have to sacrifice in terms of character development to explain the squid we just felt that the Manhattan solution was the best one for the film.”

The sequence nevertheless paid homage to the graphic novel’s creature. “The squid is actually in the movie,” observed John DesJardin. “It’s now the ‘Sub-Quantum Intrinsic Field Device.’ There’s a sign behind Ozymandias at Karnak that spells that out — S-Q-U-I-D — and it’s also on one of the monitors on the way to the reactor.”

Ozymandias discharges Manhattan’s destructive energy around the world, targeting six cities. The sub-quantum attack takes the form of a searing ball of energy that materializes midair in downtown Manhattan and decimates the city. Frantic Films previsualized the event, helping to choreograph the physics of the blast — first focusing on a news vendor and a young man at a newsstand observing zero-gravity phenomena on the street, followed by a ring of energy that slices buildings apart, and then a shockwave. Snyder shot foreground characters on the Vancouver backlot and background performers exiting their cars. John DesJardin then shot several stages of elements and clean plates, including bystanders suspended on wires. “We shot wire performers high-speed,” explained DesJardin. “The other victims were stunt guys reacting to the blast. Imageworks extracted geometry of the street, added CG cars and flying debris, and created a pullback as the shockwave came toward camera. We also had a higher angle, where we added a lot of destruction and people on the street rendered in CG.”

For an aerial view of energy scything buildings, Imageworks generated a 3D re-creation of Times Square, with even greater detail than the studio had built for the *Spider-Man* films. “We had previously built interiors for rooms that you could see inside windows,” recalled Pete Travers, “but we’d never had to model the whole structure and tear it all apart.” Senior technical animator Joseph Pepper developed shattering simulations over a period of five months. “Joseph would periodically show us a test of a few buildings here and there, and they were always promising; but it was a daunting prospect to break up the entire city region, where every building had to shatter.”

For a series of organic expansions, Imageworks combined rigid dynamic effects with an energy blast supervised by Darren Lurie. “First the ring expanded,” explained Travers. “That sliced through buildings at an acute angle. As a result of the slice, the buildings slid apart, falling toward the center. The concussion sphere then expanded, knocked the buildings back and knocked other buildings down. Then a pulverizing sphere expanded and disintegrated everything. It was very difficult to split the simulation into pieces because the effects were so interactive.”

Dr. Manhattan, grown to giant size, returns to earth and smashes into the Karnak control room to face Ozymandias. Physical effects provided on-set interaction of Manhattan’s limb breaking through the control room ceiling. “DJ wanted practical elements dropping into set,” related Joel Whist. “That involved pouring our own breakaway glass for three weeks to make enough debris. It was tricky

because the actor was in the shot, not a stunt double, and there were three cameras seeing the whole room, so we couldn't block the lighting." To create Manhattan's interactive glow, visual effects placed a large blue balloon-light above the set, while Whist's team rained breakaway material from a two-stage drop platform attached to a Genie Lift. "We had three platforms with two four-by-eight drop sheets stacked on each one, full of breakaway glass and foam to mimic steel beams."

Director of photography Larry Fong used strings of blue LEDs to simulate the intrusion of Manhattan's limbs into the set. Imageworks integrated Manhattan by rotoscoping practical falling debris and adding 3D rubble. For an angle of Ozymandias looking up at Manhattan's giant hand, Zack Snyder filmed Matthew Goode reacting against a greenscreen. Imageworks used a tiled background plate to re-create the control room ceiling, with a dynamic simulation of breaking glass and steel.

The film concludes with Dr. Manhattan preventing Rorschach from exacting revenge on Ozymandias and voluntarily taking his leave of the human race after Ozymandias' attack successfully brings peace among survivors. "In the original script," recalled Zack Snyder, "Nite Owl killed Ozymandias with the Owl Ship at the end. It was dramatic, but I always felt that the whole point of *Watchmen* was the fact that Ozzy doesn't die. His plan works — world peace restored. He was right to kill millions! That was the dilemma that I wanted people to discuss as they walked out of the movie theater: was Ozzy right, or was Rorschach? Unlike a typical superhero movie, this had a moral dilemma at the end."

To round off the adaptation, the filmmakers addressed pieces of the graphic novel that overflowed the movie's 163-minute theatrical release with extended scenes planned for the DVD release and its supplemental features. Under the Hood was conceived as a mock documentary based on the book's interstitial chapters of newsprint-style reports explaining *Watchmen* mythology. Snyder also filmed sequences on the New York City street set which, like the graphic novel, dipped in and out of a horror comic rendered in the E.C. Comics style.

The gory pirate comic — *The Curse of the Black Freighter* — employed 2D animation created by Reel FX Entertainment, overseen by 300's visual effects supervisor Chris Watts. Rising Sun Pictures visual effects supervisor Dennis Jones produced transitions to and from live-action plates of a young comic fan reading at a newsstand. 2D lead Ben Warner used 2½D projections in *The Foundry's* *Nuke* and Apple's *Shake* to fashion digital extensions of the backlot set, then the team devised transitions between live-action and hand-drawn graphics. "The cel animation was pretty clean in the print style of the graphic novel," said Dennis Jones. "We bridged that gap by applying a four-color print process style, and then transitioned to a style that matched the halftones and saturated colors of Dave Gibbons' artwork."

The multimedia additions, reconstituted into the expanded director's cut, resulted in more than four hours of screen material — an extraordinary measure, by any standard, of the filmmakers' determination to remain faithful to the novel's labyrinthine and ambitious intent. "Thematically, the film is very true to the source material," concluded John DesJardin. "We took many images right out of the book. But ultimately the audience will have to bring its own interpretation to the film. I just know I've been really happy to work with people who cared so much about the book. It made everybody want to bring their best efforts to the work."

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Into Inkworld

image

Article by Jody Duncan

Director Iain Softley's *Inkheart* brings to the screen the novel by Cornelia Funke, which recounts the story of bookbinder Mortimer Folchart (Brendan Fraser) — a 'silvertongue' who transports characters and objects into and out of books through the act of reading aloud — and his young daughter, Meggie (Eliza Bennett). After inadvertently reading his wife Resa (Sienna Guillory) into the pages of *Inkheart*, Mo spends the next nine years searching for a copy of the rare book, so that he might free his wife from her banishment in the fictional realm. Along the way, Mo contends with *Inkheart* characters he has read out of the story: Dustfinger (Paul Bettany), a dashing fire-wrangler who longs to return to Inkworld, and Capricorn (Andy Serkis), a ne'er-do-well who has adapted only too well to the corporeal world, and has seized, with the help of his black-jacketed henchmen, an Italian village. Angus Bickerton served as visual effects supervisor for the production, and divided the show's 594 effects shots among Double Negative, The Senate, Cinesite, *Rainmaker* and Peerless Camera Company.

After a prologue sequence that hints at Mo's unusual gift as he reads aloud to the baby Meggie, the action cuts to the present day, with his discovery of a copy of *Inkheart* in an antique bookstore. As Mo emerges from the shop, he is confronted by Dustfinger, whose unique ability to manipulate fire is demonstrated throughout the movie in shots realized by Cinesite. "Any time you see a fire effect involving Dustfinger," said Angus Bickerton, "it is a Cinesite shot. Paul Bettany rehearsed heavily to actually handle fire for those scenes, but at the last moment, the insurance people said, 'We're not letting you anywhere near flames.' So, for example, in a scene where he juggles fiery ropes, he just handled the ropes, without any flame; and then Cinesite added the flame effects to the shots. To help with that, we incorporated interactive lighting on the set where we could. Paul Corbould, the special effects supervisor, built a couple of staffs with built-in LED lights to throw light on Paul Bettany's face and body as he juggled them and swung them around."

Bickerton considered using CG fire for the Dustfinger shots, but ultimately decided to shoot real fire elements, photographing fire jugglers going through complicated moves with flaming ropes on a black-screened stage. Cinesite then tracked those fire elements to shots of Bettany doing similar moves with the unlit ropes, tagged with bright yellow markers at the extremities to help the visual effects team ascertain where the end of the rope was at any point in time. "We tracked the ropes in 3D so we could figure out where each rope was in space, even when it was hidden from camera," explained Cinesite 2D supervisor and lead compositor Zave Jackson. "There were times when the end of the rope was moving so fast you couldn't see it, or it would go behind part of his body. By tracking it in 3D we were able to predict where the end that he was holding in his hand and also the end that was furthest away from him would be. Those tracks were taken into Maya and manually adjusted over the plate to make them more accurate. Using that tracking data, we were then able to place the flame elements."

Because the fire jugglers' movements did not precisely match Bettany's in the plates, Cinesite had to build up appropriate fire elements from select frames. "It was somewhat of a manual

construction process to build the more complex juggling sequences,” said Jackson. “It was a case of taking sections of the live-action juggling fire and separating it out, sometimes frame by frame, and tracking it in. It was still a real bonus to have live footage of fire actually being spun in a similar — if not exact — way, though, because it meant that the curve of the flame and the motion blur that the flames created were authentic. In the end, it worked very successfully.”

To augment the on-set interactive lighting and better integrate the flame elements, Cinesite added some lighting to the shots in 2D, casting highlights and reflections onto Dustfinger’s body. “The interactive lighting they’d done on the set was fairly general,” observed Jackson, “because they did not know exactly what the timings would be with the flames; whereas, we could put in very specific interactive lighting in the composite. We did have some useful reference, because the real fire jugglers had worked with the flaming ropes on location before Paul Bettany came out and did his run with the unlit ropes; so we could see how the flames behaved in those lighting conditions. There were a lot of interesting artifacts that they created in the lens because the film was shot anamorphic. At the top and bottom of the frames we’d get these little orange, glowing arcs, and Angus and the director were very keen that we put those back in to help sell the shots.”

In one fire-manipulation shot, Dustfinger produces a jet of flame that forms a circle, and then creates a second stream in an arrow shape that shoots through the ring of fire. To get the elements for the shot, Paul Corbould’s special effects team set up a circular metal hoop on stage at Shepperton Studios. “They set out compressed air and a flammable liquid around the hoop to create rings of fire,” explained Jackson, “but, unfortunately, it was very difficult to make the fire behave exactly as they wanted. It wound up creating semicircles of flame. In the composite, we took these flame semicircles and built full circles. Then, for the effect of the arrow of flame going through the center of the circle, we used one really nice take of a jet of flame.”

Mo and Meggie, fleeing from Dustfinger, drive to the lakeside house belonging to Meggie’s great-aunt Elinor (Helen Mirren). Production shot plates for establishing views of the house and surroundings at Lake Como, Italy. *Rainmaker’s* London office — which has since closed its doors — augmented the plates with digital environmental work. “In addition to the plates they’d shot at Lake Como,” said visual effects supervisor Adam Gascoyne, “they shot a building at Hever Castle, in Kent, for Elinor’s actual house. We had to blend those two locations, placing the house in Lake Como. We painted out unwanted elements to make Elinor’s house look more isolated, and Lizzie Bentley did digital matte paintings of trees to extend and change the shape of the landscape somewhat. We also ended up building the entire house 3D because we had to see it from several different angles, at different times of day. Jon Opgenhaffen built a CG house model, and projected onto it textures taken from the real location at Hever Castle. He also extended the original building to give it an upstairs floor.”

At the lakeside house, the black-jackets capture Mo, Elinor and Meggie and transport them by van to Capricorn’s compound. Cinesite created establishing shots of Capricorn’s town, augmenting footage shot on location in Balestrino, Italy, a 16th-century town that was abandoned by its residents in the



mid-1900s, due to instability caused by its slow slide down the hillside. “Cornelia Funke, the author of *Inkheart*, had visited this town on holiday and it became a source of inspiration for Capricorn’s hideout,” noted Angus Bickerton. “It’s in the mountains of the Liguria region of Italy, at the top of the boot, and it is beautiful there. A lot of the architecture is stone and drywall — John Beard, the production designer, just had to go in and redress the town. It was quite a heavy redress, but the bones of what we needed were there.”

Capricorn’s hilltop castle was actually a 1/10-scale miniature, built by Leigh Took and his crew at Mattes & Miniatures. “We wanted to give the impression that Capricorn had shored up and added to the castle over the years,” explained Bickerton, “and so, we came up with this blocky design for the miniature, which also reflected the style of medieval Italian castle architecture.” Sections of the miniature were made collapsible to accommodate finale scenes in which the castle is destroyed. The visual effects crew shot the miniature at Bray Studios — outdoors, in daylight — over the course of a two-week model shoot. “At 1/10 scale, it stood about 12 feet tall by 18 feet wide — so it was pretty big. And then, in order to get the appropriate angles, it had to be put onto a deck that was 20 feet in the air. So it stood quite high out in a field, which gave us a clear horizon. We shot all the establishing views of it, matching plates from Balestrino, and Cinesite composited the miniature into those plates.”

Cinesite’s establishing shots combined the castle miniature not only with the 4K Vistavision plates shot at Balestrino, but also with those shot at a second, more mountainous location. “They wanted to make it look like the castle was sitting on a more dramatically dangerous precipice of rock,” observed Zave Jackson, “so our matte painter, Juan Jesus Garcia, combined these 4K Vistavision plates to create this artificial environment. In one shot, we pan from the valley floor, all the way up the mountainside to reveal Capricorn’s castle on the hilltop. That was a fully 2D shot, combining Juan’s matte paintings and the castle model.”

The initial pan-up reveal includes a view of the van carrying Capricorn’s captives crossing a stone bridge that spans a deep gorge and river. Though the bridge was an actual architectural feature of the town, Softley could not film the shot of the van driving across it, for safety reasons. To realize the shot, Bickerton’s crew bought a scaled model of the van online, painted it to match the live-action vehicle, shot it against bluescreen, and had Cinesite composite it into the location bridge plate.

*In the fantasy adventure *Inkheart*, directed by Iain Softley, ‘silvertongue’ Mortimer Folchart (Brendan Fraser), conjures characters out of books by reading aloud. After accidentally reading his wife Resa (Sienna Guillory) into the pages of *Inkheart*, Mortimer and his daughter, Meggie (Eliza Bennett), search for a copy of the rare book so that he might read her out again. Along the way, Mortimer contends with other displaced *Inkheart* characters, such as the dashing fire-wrangler, Dustfinger (Paul Bettany). For *Dustfinger* pyro scenes, Cinesite tracked practical flame elements, shot by visual effects supervisor Angus Bickerton, to live plates filmed in Italy and on stages at Shepperton Studios.*



*The most malevolent of the transplanted *Inkheart* characters is Capricorn (Andy Serkis), who has seized an entire Italian village, including a hilltop castle, with the help of his black-jacketed minions. To realize Capricorn’s rustic town — where Mortimer, Meggie and her great-aunt Elinor (Helen Mirren) are taken captive — Cinesite nestled a 1/10-scale castle miniature built by Mattes & Miniatures into location footage shot at Balestrino, an abandoned, but largely intact 16th-century village in the mountain region of Italy.*

The black-jackets imprison their captives in the castle stables housing unfortunate creatures that have been read out of books improperly by Capricorn's stuttering silvertongue, Darius (John Thomson). Literary stable-mates include the crocodile, with ticking clock, from *Peter Pan*, a practical creature created by Millennium Effects. "It was very simple," said Millennium creature effects supervisor Neill Gorton. "It had some jaw and neck movement, and it was built only from the middle of the beast forward. Since it was going to be in water, we operated it with simple rod controls from behind."

Millennium Effects built a radio-controlled head and suit, worn by performer Paul Casey, for shots of a minotaur transplanted from the book world. "We had Paul body-scanned," explained Gorton, "and we machined out a really nice body cast of him. Martin Rezard sculpted the minotaur in clay over the body form, and then we created a latex body suit and head. The radio-controlled head had rotational jaw movement, a moving tongue, lip movement, eye blinks and rolling eyes." Rezard and Gustav Hoegan operated the radio-controlled head on set. An originally scheduled three-day shoot with the minotaur was extended to 14 days when Softley decided to expand the creature's role. "Iain really liked it, and so he came up with additional scenes in which to use it. The only problem was that it had been built to withstand three days of shooting, not two weeks. We were constantly working on maintenance of the head, making sure the fur and everything else stayed intact for those additional eleven days."



Matching plates shot in Balestrino, Bickerton and his crew filmed the miniature in an open field near Bray Studios, mounting it to a 20-foot-tall platform to capture the appropriate camera angles.

The Senate enhanced the practical minotaur suit and head in postproduction. “We decided, after the shoot, that we wanted the minotaur to appear larger,” noted Angus Bickerton. “So The Senate rotoed out Paul Casey in the suit, scaled him up by 30 percent, and put him back in.”

“The creature wasn’t imposing enough, in terms of scale,” added The Senate visual effects supervisor Richard Higham, “so we scaled him up to make him more intimidating. In addition to rotoing and isolating him out, we had to paint in bits of the background when we reinstated the scaled-up version.” The Senate also tracked in smoke elements that Bickerton had shot on stage to suggest the minotaur’s snorting breath and steam rising off its back. “The elements were really useful, for the most part; but there were occasions where we could not get any of the smoke elements to track appropriately to the nostrils, due to the performer’s movement. So, on two or three shots, we supplemented the elements with some Maya fluids that we tracked in. Using that, we were better able to create the sense that the nose was actually the source of the steam; and, as the head moved, we could create a little trail. We also added some CG flies buzzing around the minotaur to make it seem more like a dirty old creature.”



In the stables of Capricorn’s town, Mortimer, Meggie and Elinor share imprisonment with a number of fictional characters that have been read out of books by Capricorn’s inept silvertongue. Millennium Effects provided two of the characters – a minotaur and the crocodile from Peter Pan – as practical creature effects. Millennium sculptor Martin Rezard completes the clay sculpt of the crocodile.

Also imprisoned in the stables, and temporarily grounded, are flying monkeys from L. Frank Baum’s *The Wonderful Wizard of Oz* — 3D-animated characters realized by Double Negative. Concept artist Adam Brockbank extrapolated on the illustrations of the monkeys in Baum’s original book to develop the creature’s design. “Adam did the most beautiful concept illustrations for us,” commented Angus Bickerton, “including a number of illustrations of the flying monkeys. Then, from those illustrations, Kate Hill sculpted clay maquettes — one that had two legs and the wings; and another with four limbs, plus the wings, which is the one we went with. We had the maquette cyberscanned and then gave that model to Double Negative.”

The design continued to be tweaked at Double Negative. “To make the monkeys anatomically possible,” observed Double Negative visual effects co-supervisor Ryan Cook, “to make them able to fly and so forth, there was a bit of back-and-forth with our creature development department.”

Steven Moore was the lead modeler on the flying monkeys. Robert Helms built the animation rig, and Tom Ward supervised the animation, which involved flying cycles for later scenes in which the monkeys escape the stables and fly through Capricorn's village, attacking their captors. "One of the challenges of the animation was figuring out how to make the flapping wing movement work in the shoulder blades," said visual effects co-supervisor Paul Riddle. "The wings extended straight out of the back, so coming up with a big, powerful, sweeping wing movement was tricky. Once they came up with a solution for that — a kind of double-jointed shoulder blade to lift the weight of the wings — the animation team developed the flight cycles quite quickly."



To escape the stables, Mortimer conjures the tornado from *The Wonderful Wizard of Oz*. Peerless Camera Company created the twister using custom volumetric software developed by its in-house Houdini team. To protect Balestrino's decaying architecture from further damage by physical effects rigs, Peerless re-created sections of the town in CG for shots of twister destruction.

Inside the castle, Capricorn threatens harm to the captives, forcing Mo to 'read out' treasures and riches from *One Thousand and One Arabian Nights*. Inadvertently, the reading aloud also transplants the young boy Farid (Rafi Gavron) from one of the Arabian tales to the modern-day village, and he is imprisoned along with Mo, Meggie and Elinor.

To escape the stables, Mo reads aloud from the twister chapter in *The Wonderful Wizard of Oz*, conjuring the storm. Peerless Camera Company, under visual effects supervisor Paul Docherty, created the 55-shot twister sequence, which was first prevized by the in-house Shepperton firm, Fuzzy Goat. Bickerton and the team at Peerless used the previz to block out shots, and referenced real and fictional twister footage to develop the look of the sequence. "We went online and assembled a lot of footage of real twisters," said Bickerton, "and we also looked at the film *Twister*. But of all the reference, what we liked best was the twister that was in the 1939 movie, *The Wizard of Oz*. That had been done by A. Arnold Gillespie's team, using a number of different techniques, including a gigantic stocking attached to two tracks — one in the floor, one in the ceiling — which created these fantastic shapes. They shot it overcranked, with huge machines pouring smoke into the sock as it spun out. There was something great about those images; and so, that became about 80 percent of the reference for this sequence, and 20 percent was real twister footage."

"We could not copy the twister images from the movie exactly," added Paul Docherty, "because that would have been a problem from a rights point of view. But we came up with something that had the same 1930s/40s filmic look, while still based on illustrations in the book." Peerless created the twister using custom volumetric software developed by its in-house Houdini team, led by head of R&D Patrick Ledda. "It had to be volumetric because, at one point, the camera moves inside the twister and we see lightning illuminating it, lighting up a Kansas-style farmhouse as it flies through. We couldn't accomplish that with particles and comp tricks — we had to have something that would take real lighting on the surfaces. So Patrick developed a system for that. We got a lot of help from the Houdini people, too, who are very good at getting on board with advance projects."

Though Softley preferred to use on-set effects whenever possible, the destruction of the town by the twister was also largely digital, due to the decaying nature of Balestrino's ancient structures. "The location was lovely," remarked Docherty, "but it was problematic. In fact, when they first started rolling in cranes and things for the stunts, one of them sank into the ground — and everybody freaked out. Many areas were actually dangerous, and had to be taped off — so we were limited as to where we could go on set. The end result was that we had to fake up a lot of the stunts and interaction digitally." To assist the digital re-creation of areas of the town, Bickerton shot extensive reference photographs at Balestrino, and also arranged to have its main structures lidar-scanned. From that data, Peerless created interactive events such as smashing rocks, flying debris and collapsing structures, using a combination of Maya and Houdini. "There's one shot where the characters look up at the top of the wall, and there is a little rounded tower that blows to bits when the wind hits it. That was all CG. There are three shots in that sequence that are entirely CG — and I defy anybody to find them." Peerless integrated a 1/5-scale miniature, built by Mattes & Miniatures and photographed against greenscreen, for a scene of a scaffolded wall collapsing behind the characters.

Another aspect of Peerless' work on the sequence was creating a consistent overcast, stormy look to live-action plates that often had been shot in extremely bright, sunny weather. "Roger Pratt, the director of photography, and his crew ran around like maniacs, putting up big flags to block out the sun," observed Docherty, "but obviously, they couldn't do that everywhere. So, some of the heaviest work we did on the sequence was just grading everything and working on the lighting to make it look like it all took place on an overcast day. That was harder to do than the tornado!" Twister sequence shots set in the town's central square required Peerless to replace a real tree — which, in the sunny plate, was casting very large, dark shadows — with a CG tree, complete with leaves animated in XSI. Ditch Doy, Peerless' head of CG, oversaw the work, replacing the tree and much of the central square with CG elements.



In keeping with the Wizard of Oz motif, a farmhouse ripped from its foundation and swept aloft by the twister drops onto a road as Mortimer and his charges flee the town in a commandeered van.



Mattes & Miniatures built a farmhouse miniature, which was spun about on cables for the aerial shots, and then dropped from a height of eight feet onto a scaled road-and-landscape set. Peerless composited the miniature into live-action plates.

As the storm intensifies, an airborne jeep lands in front of the escaping characters. The actors were shot on a sunny day in Italy, with air cannons and other physical effects suggesting the absent jeep's impact on the ground. Months later, on a snowy day at Shepperton, the jeep was shot separately, dropped from a crane. "To get that all together lighting-wise was quite difficult," Docherty noted. "One of our senior comp artists, John Swinnerton, did the extremely complex compositing of the background, CG elements, real jeep and effects elements."



Throughout the film, Inkheart author Fenoglio (Jim Broadbent) envisions his fantasy world as he imagined it. To realize these flashes into Inkworld, Rainmaker enhanced photography of picturesque English landscapes or generated entirely synthetic, hyperreal environments. A boom-up from an Inkworld lake reveals a castle backed by an abstract mountain range. Rainmaker modeled the 3D castle and surroundings, filling the frame with animated 3D elements and live-action people. Rainmaker also added mist, dandelion pollen floating in the air, and god-rays to give the scene an idyllic look.

Mo and his charges commandeer the van that transported them to Capricorn's village and drive away in it. The Kansas farmhouse that drops onto the road as the twister subsides was built as a 1/3-scale miniature by Mattes & Miniatures. "Leigh Took and his team built it with a collapsible internal framework," explained Angus Bickerton. "We built a foreground road section on stage at Bray Studios, and dropped the house from a height of about eight feet onto this foreground miniature landscape." At Peerless, Emeline Tedder composited the miniature element into live-action plates, adding digital debris swirling around the house.

The sequence concludes with a shot of a real-world resident suddenly dropping into a field in the book's Kansas farm, represented in an illustration-style matte painting. "It's a gag shot," noted Paul Docherty, "and it was our homage to the great matte artist and visual effects pioneer Albert Whitlock. It was an attempt to re-create that forties matte painting look, making heavy use of Whitlock's 'soft split' techniques, especially in the skies." Artists Tim Ollive and Steve Begg executed the shot. "Steve Begg is a visual effects supervisor; and so he is usually a client for us. But he had some spare time, and he got rather excited about what we were doing because he loves old-style opticals. So he came in on a freelance basis and worked with Tim to put that together. Iain was very pleased with it."

Intent on finding a copy of *Inkheart*, Mo, Meggie, Elinor, Dustfinger and Farid make their way to the Mediterranean town where its author, Fenoglio (Jim Broadbent), lives. Fenoglio, delighted at the prospect of meeting his characters face to face, conjures up Inkworld in his mind's eye. "Iain had this idea that, as Fenoglio recalls chunks of his book, we'd get these mini-flashbacks of scenes, little vignettes in Inkworld," said Angus Bickerton. "He envisioned Inkworld as being very rich and Technicolor."

Rainmaker took charge of the Inkworld scenes, enhancing picturesque English landscapes and, in some cases, creating entirely synthetic environments. “They wanted these environments to feel as if they were bubbling with hyperreal color and wildlife,” said Adam Gascoyne, “with odd-shaped mountains in the backgrounds. Inkworld had to feel a bit more abstract than the real world.” In one Inkworld shot, the camera captures three water nymphs in a lake — live bluescreen elements of actresses shot in a tank — and then skims over a lake. “From the moment we leave the water nymphs, it is a completely CG environment. Our head of CG, Sally Goldberg, oversaw the creation of CG water, CG water lilies, CG deer drinking at the water’s edge, CG mayflies. The only real element is a swan that Angus shot.” The camera then flies through a canopy of trees. “The trees are initially a matte painting projected onto cards to produce a 2D shift in parallax at the start of the shot. Then, as we fly up through the trees, they become fully rendered 3D trees with animation on the branches and leaves. They were rendered with transparent shadows and a specially written leaf shader to create the backlit effect that is so difficult to achieve with normal 3D rendering. We were able to get the incredible density within the trees by using procedural techniques to create the individual leaves and twigs.”

The move through the trees acts as a reveal to a mountainous landscape and castle. “The castle and the terrain surrounding it were an entirely 3D creation,” observed Gascoyne. “Based on initial production designs, we took source material from Italian and German architecture, designing a castle-topped mountain village full of lush vegetation and life. The castle is a fully-textured and lit 3D model filled with plenty of 3D props, some animated, and live-action elements of people scattered liberally throughout. We enjoyed building in an immense level of fine detail, from the architectural subtleties of the era to the horse and cart rolling down the road past a flock of grazing sheep — all 3D elements. The shot was put together in Shake by lead compositor Simon Hughes. To get the hyperreal, idyllic look, we did a lot of work on the color grade, added mist and God-rays coming through tree branches, and dandelion pollen floating in the air.”

Mo, Dustfinger and Farid return to Capricorn’s town to rescue Resa, previously read out of *Inkheart* and now working as a servant in Capricorn’s castle. They are soon joined in the compound by Fenoglio and Meggie, the latter having learned that she, too, is a silvertongue. Locked away in the village crypt, Meggie is informed that she will be forced that very evening to read aloud from *Inkheart* and conjure the terrible Shadow, a beast comprised of smoke, ash and ember.

As Meggie is brought to the village amphitheater for the ceremonial arrival of the Shadow, Dustfinger and Farid create a diversion to help their friends by setting the castle on fire, shooting



Dustfinger and Farid (Rafi Gavron) – a displaced character from One Thousand and One Arabian Nights – set fire to Capricorn’s castle. For shots of the characters walking the corridors, shooting flames at hanging draperies, special effects supervisor Paul Corbould and his team produced flame streams with pressurized air cylinders and hoses that fired flammable liquid. Bickerton shot flames against black, and then Cinesite tracked those elements to the actors’ hands in the live-action plates. Cinesite also extended the corridor set, compositing in a duplicate corridor, which the special effects team had burned in controlled fires that ranged from small blaze to raging inferno.

streams of flame to alight hanging draperies as they walk the castle corridors. At Shepperton, Paul Corbould's team set up pressurized air cylinders and hoses that fired flammable liquid to produce the fire streams. "This rig that could shoot petrol and air at the same time looked like some kind of metal dragon," remarked Zave Jackson at Cinesite, which composited the shots. "It produced these bursts of flame that we filmed on stage in the blackscreen studio and then tracked to the shots. We composited these elements onto the hands of the characters to make it look as if they were blowing jets of flame, timed to the bursts of flame that happened on the set in reality. It was a 2D process."

In the plates, the actors mimed the action of blowing jets of flame toward the draperies, which the special effects crew had rigged to catch fire. Separately, the special effects team burned a duplicate corridor with controlled fires that ranged from small blaze to raging inferno. Cinesite used the different stages of burning corridor to extend the live-action set. "Our task was to extend that corridor and create the impression that the characters had already walked a long section of it and set it on fire," Jackson explained. "Using these plates of the castle corridor on fire at different stages, we were able to build that up and create the impression of a burning corridor disappearing into the background. The one tricky thing was that the corridor had black and white, diamond-shaped tiles, which required us to use 3D tracking techniques to track in a substitute floor and extend that pattern back into the distance."

In the amphitheater, the Shadow appears and begins to move toward Resa, held captive in a net. "Iain often uses pieces of art for reference," observed Angus Bickerton, "and our first point of reference for the Shadow was a beautiful Goya painting called 'El Colosso,' which has a huge, bull-like figure towering over a frightened town. Adam Brockbank started with that; and then, using images of pyroclastic clouds as texture, he created illustrations of this huge smoke demon." Part of the challenge of designing the Shadow was accommodating Softley's vision of a creature devoid of a defined shape or form. "Double Negative was going to generate clouds of smoke for the Shadow; but they needed something to emit that smoke from, some underlying model. So Kate Hill sculpted Adam's design, and Double Negative used that to build a Shadow computer model."

"We approached the character, initially, as a traditional biped character," elaborated Ryan Cook. "We built a demon-like creature that was a traditional CG model, without any smoke, and used that to previz the Shadow shots."

To block out Shadow action, Bickerton shot a very tall performer named Marnix Van Den Broeke on digital video, physically acting the character and moving through a cardboard art department model of Capricorn's town. "We figured out some beats of the Shadow action," noted Bickerton, "shot it, and then cut that together into a sequence. Marnix also played the Shadow on the set, stomping around on stilts, holding a long stick for eyelines. As soon as we got a cut sequence, we went back into the lobby at Double Negative and, now using the actual shots, we shot Marnix again on DV, from three witness cameras, getting him to line up very crudely with the shots that we had. We employed our in-house team to composite Marnix in those shots, and from that Iain and Martin Walsh, the editor, could cut the sequence together — to the point where we could almost sign off on the animation. Double Negative just match-animated to Marnix's performance, using the witness camera footage."

Though Van Den Broeke's performance was the basis of the Shadow animation, animators had to adjust for the fact that the animation of the underlying demonic face ultimately would be shrouded in heavy clouds of smoke. "Animation supervisor Tom Ward and his team had to interpret what Marnix was doing, facially, into something that would be recognizable through the smoke," explained Ryan Cook. "Marnix had expressed a lot of anger through his face, and we had to carry that all the way through to the final demon. Even though he was shrouded in smoke, it was still necessary to see some expression in the Shadow's eyes and a suggestion of a mouth. A great deal of emphasis was placed on the demon's brow to create expressions of anger and pain. The animators found that by manipulating the CG 'lava field' that made up the Shadow's face, they could create those expressions."

Toggles enabled artists to dial flames and lava up or down, which determined how much lava was visible on the face. "There was a bit of back-and-forth with what Iain wanted to see," observed Paul Riddle. "At some points he wanted the character to be more mysterious and hidden in smoke; and at other points, where the creature's personality had to come through, its features had to be more solidified."

CG supervisor Gavin Graham oversaw the development of the Shadow's pyroclastic cloud look. The roiling smoke clouds were generated through a custom fluid simulation engine called Squirt, developed by Marcus Nordenstam, and were rendered through a custom voxel-based renderer that Double Negative had used to produce smoke effects for Oliver Stone's World Trade Center. "One of our senior R&D developers, Jeff Clifford, further developed our volumetric renderer, DNB, for *Inkheart*," said Ryan Cook, "and we used that as a basis for per-shot simulations."

In the film's finale, the Shadow transforms town structures and inhabitants into ash, and then absorbs them into its smoky form. To realize the grand destruction, Double Negative 2D leads Victor Wade and Jon Bowen oversaw the creation of digital environments. "The entire finale with the Shadow occurs within this large amphitheater," noted Paul Riddle, "which is part of Capricorn's lair. The set itself was bluescreen, and we had to extend beyond the set, adding the rest of the village, including Capricorn's castle miniature. All of the surrounding battlements, brick walls and so on were a



The film's finale has Meggie – discovered to be a silvertongue – reading out from the pages of *Inkheart* a demonic creature of smoke and ash, called the Shadow. The action is set in an amphitheater in Capricorn's town, built as a partial bluescreen set at Shepperton Studios. Double Negative extended the stage set, surrounding it with a 360-degree digital cyclorama comprised of location plate photography stitched together with its in-house software, Stig. Double Negative blended between the live set and cyclorama with 3D geometry and matte-painted elements, and also composited the miniature castle into some shots.



Meggie rewrites the ending of *Inkheart*, causing the Shadow to advance on Capricorn. To block out Shadow action, Bickerton filmed a tall performer moving through a cardboard art department model of Capricorn's town. After the sequence had been shot and edited, Bickerton and Double Negative filmed the performer again with witness DV cameras, lining him up with shots from the cut sequence. Double Negative then match-animated its Shadow to that performance. The Shadow's pyroclastic cloud look was generated through a custom fluid

combination of geometry and matte painting. We created a huge, 360-degree cyclorama that went all the way around the amphitheater set, and that cyclorama was made up of plates shot at various locations. We stitched them together using our in-house software, Stig.” Double Negative graded the plates, which had been photographed in daylight, to reflect the night setting of the finale, and also added atmospherics.

simulation engine called Squirt, then rendered through a voxel-based renderer.

The Shadow turns and advances on Capricorn when Meggie quickly rewrites the ending of *Inkheart* on her arm. Confronted by the Shadow, Capricorn transforms into a marble statue form, then to ash, and then crumbles and blows away, consumed by the smoke demon. Double Negative built a Capricorn model in the computer, animated it using Maya, and then turned it over to a special Houdini team, led by effects animator Louis Dunlevy. “Usually,” observed Ryan Cook, “we use Maya for our effects animation; but for this Capricorn’s demise sequence, we had a breakaway team working on Houdini for the crumbling and shattering effect. Then it was passed back into our Maya pipeline so we could do the dynamics and smoke parts of it.” Double Negative’s Houdini team also produced shots of the Shadow’s demise, which brings the finale to a close. “We passed our creature through Louis’ team, which crumbled and collapsed the Shadow; then it was run back through our fluid simulation to generate the secondary smoke that comes off of it.”

Inkheart ends with evil thwarted and families reunited — Mo’s in the real world and Dustfinger’s in Inkworld. Representations of both realms, fictional and real, were influenced by the art background of the film’s director, and by his and Bickerton’s commitment to photorealism. “Iain Softley likes things to be photographically real where possible,” stated Angus Bickerton, “and that’s always my preference, as well. We had miniatures and real fire elements and the like in this movie because, for me, if you can touch something and see it and work with it in the real world, so much the better.”



Overtaken by the Shadow, Capricorn transforms into a marble statue form, then to ash, and then crumbles and blows away, consumed by the smoke demon. Double Negative built a Capricorn model in the computer, animated it in Maya, and then turned it over to a special Houdini team to execute the crumbling and shattering effect. A final pass in the Maya pipeline enabled the digital effects team to run smoke and other dynamics simulations.

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